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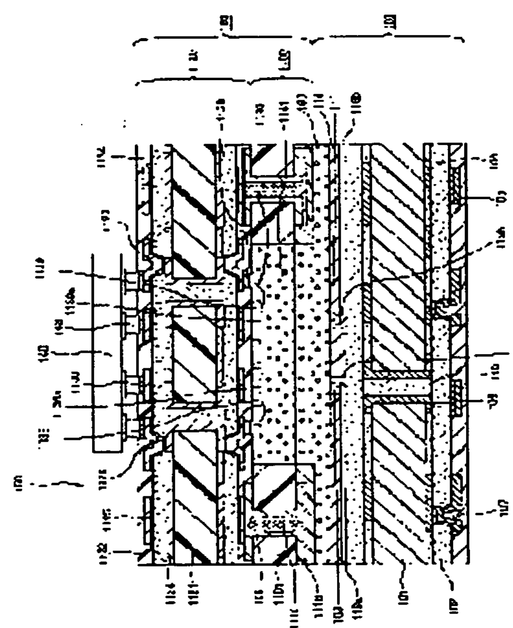
(54) DEVICE FOR OPTICAL COMMUNICATIONS AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a device for optical communications whose connection reliability is high by reducing the connection loss between packaged optical parts and which is small-sized by integrating optical parts and electronic parts necessary for the optical communications by constituting the device of a printed circuit board for packaging an IC chip where an optical device is packaged at a specified position and a multilayer printed wiring board where an optical waveguide is formed at a specified position.
SOLUTION: The device for the optical communications is constituted of at least a printed board for packaging the IC chip possessing an area for packaging the optical device where the optical device is packaged and also a layer filled with resin for an optical path is formed and the multilayer printed wiring board where at least the optical waveguide is formed, so that an optical signal is transmitted with the optical waveguide and the optical device through the layer filled with the resin for the optical path.



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CLAIMS

[Claim(s)]
[Claim 1]
The substrate for IC chip mounting which has the field for optical element mounting in which the resin packed bed for optical paths was formed at least while the optical element was mounted,
It is the device for optical communication which consists of a multilayer printed wiring board with which optical waveguide was formed at least,
The device for optical communication characterized by constituting said optical waveguide and said optical element so that a lightwave signal can be transmitted through said resin packed bed for optical paths.
[Claim 2]
The device for optical communication according to claim 1 with which the closure resin layer is formed between said substrates for IC chip mounting and said multilayer printed wiring boards.
[Claim 3]
Said closure resin layer is a device for optical communication according to claim 2 whose transmission of communication link wavelength light is 70% or more.
[Claim 4]
The device for optical communication according to claim 2 or 3 with which the particle is contained in said closure resin layer.
[Claim 5]
The multilayer printed wiring board of said resin packed bed for optical paths, and the device for optical communication given in any 1 of claims 1-4 by which at least one micro lens is arranged in the field which counters.
[Claim 6]
The device for optical communication given in any 1 of claims 2-4 with the refractive index of said micro lens at least one micro lens is arranged in the multilayer printed wiring board of said resin packed bed for optical paths, and the field which counters, and larger [said closure resin layer] than a refractive index.
[Claim 7]
Said optical element is a device for optical communication given in any 1 of claims 1-6 which are a photo detector and/or a light emitting device.
[Claim 8]
While an optical element is mounted, after manufacturing separately at least the substrate for IC chip mounting which has the field for optical element mounting in which the resin packed bed for optical paths was formed, and the multilayer printed wiring board with which optical waveguide was formed at least,
Between the optical element of said substrate for IC chip mounting, and the optical waveguide of said multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,
Furthermore, the manufacture approach of the device for optical communication characterized by forming a closure resin layer by performing hardening processing after slushing the resin constituent for the closures between said substrates for IC chip mounting and said multilayer

printed wiring boards.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the manufacture approach of the device for optical communication, and the device for optical communication.
[0002]
[Description of the Prior Art]
In recent years, attentions have gathered for the optical fiber focusing on the communication link field. In especially IT (information technology) field, the communication technology which used the optical fiber for maintenance of the high-speed Internet network is needed.
An optical fiber **1 Low loss, **2 High bandwidth, **3 A narrow diameter and a light weight, **4 No guiding, **5 In the communication system using the optical fiber which has the descriptions, such as saving resources, and has these descriptions, compared with the communication system using the conventional metallic cable, the number of repeaters can be reduced sharply, construction and maintenance become easy, and economization of communication system and high-reliability-ization can be attained.
[0003]
Moreover, since an optical fiber can multiplex the light of the wavelength from which not only the light of one wavelength but many differ to coincidence with one optical fiber, it can realize the transmission line of the large capacity which can respond to various applications, and can respond to image service etc.
[0004]
Then, in network communication, such as such the Internet, using the optical communication using an optical fiber not only for the communication link of a backbone but for the communication link with a backbone and terminal equipments (a personal computer, mobile one, game, etc.) and the communication link of terminal equipments is proposed.
[0005]
Thus, when using optical communication for the communication link with a backbone and a terminal equipment etc., in order for IC which performs information (signal) processing in a terminal equipment to operate with an electrical signal, it is necessary to attach the equipment (henceforth light/electric transducer) which changes the lightwave signal and electrical signal of optical -> electric transducer, electric -> phototransducer, etc. into a terminal equipment. So, in the conventional terminal equipment, for example, optics, such as a package substrate which mounted IC chip, a photo detector which processes a lightwave signal, and a light emitting device, etc. were mounted separately, electric wiring and optical waveguide were connected to these, and a signal transmission and signal processing were performed.
[0006]
[Problem(s) to be Solved by the Invention]
In such a conventional terminal equipment, since IC mounting package substrate and the optic were mounted separately, the whole equipment became large and had become the factor which bars the miniaturization of a terminal equipment.

Moreover, in the conventional terminal equipment, since the distance of IC mounting package substrate and an optic was separated, electric wiring distance is long and it was easy to generate the signal error by a cross talk noise etc. at the time of a signal transmission.
[0007]
[Means for Solving the Problem]
Then, this invention persons completed the device for optical communication of this invention which consists that it can contribute to the miniaturization of a terminal equipment of a header and the following configuration while being able to attain the optical communication which is excellent in connection dependability by carrying out opposite arrangement of the substrate for IC chip mounting and multilayer printed wiring board which mounted various optics as a result of inquiring wholeheartedly.
Furthermore, since the stress which the foreign matter which is floating the inside of air does not enter between each optic, in addition is generated between the substrate for IC chip mounting and a multilayer printed wiring board was able to be eased when a closure resin layer is formed in the device for optical communication between the substrates for IC chip mounting and multilayer printed wiring boards which carried out opposite arrangement, it found out becoming the device for optical communication which is more excellent in dependability.
[0008]
That is, the device for optical communication of this invention is a substrate for IC chip mounting which has the field for optical element mounting in which the resin packed bed for optical paths was formed at least while the optical element was mounted,
It is the device for optical communication which consists of a multilayer printed wiring board with which optical waveguide was formed at least,
The above-mentioned optical waveguide and the above-mentioned optical element are characterized by being constituted so that a lightwave signal can be transmitted through the above-mentioned resin packed bed for optical paths.
[0009]
It is desirable to form the closure resin layer in the device for optical communication of this invention between the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board, and, as for the above-mentioned closure resin layer, it is desirable for the permeability of communication link wavelength light to be 70% or more in this case.
Moreover, it is desirable to contain the particle in the above-mentioned closure resin layer.
[0010]
Moreover, it sets to the device for optical communication of this invention. It is desirable to arrange at least one micro lens in the multilayer printed wiring board of the above-mentioned resin packed bed for optical paths and the field which counters. Moreover, at least one micro lens is arranged in the multilayer printed wiring board of the above-mentioned resin packed bed for optical paths, and the field which counters. When the closure resin layer is formed between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, as for the refractive index of the above-mentioned micro lens, it is desirable that it is larger than the refractive index of the above-mentioned closure resin layer.
[0011]
Moreover, as for the above-mentioned optical element, in the device for optical communication of this invention, it is desirable that they are a photo detector and/or a light emitting device.
[0012]
After the manufacture approach of the device for optical communication of this invention manufactured separately at least the substrate for IC chip mounting which has the field for optical element mounting in which the resin packed bed for optical paths was formed, and the multilayer printed wiring board with which optical waveguide was formed at least while the optical element was mounted,
Between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,

Furthermore, after slushing the resin constituent for the closures between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, it is characterized by forming a closure resin layer by performing hardening processing.
[0013]
[Embodiment of the Invention]
Hereafter, the device for optical communication of this invention is explained.
The device for optical communication of this invention is a substrate for IC chip mounting which has the field for optical element mounting in which the resin packed bed for optical paths was formed at least while the optical element was mounted,
It is the device for optical communication which consists of a multilayer printed wiring board with which optical waveguide was formed at least,
The above-mentioned optical waveguide and the above-mentioned optical element are characterized by being constituted so that a lightwave signal can be transmitted through the above-mentioned resin packed bed for optical paths.
[0014]
Since the device for optical communication of this invention consists of a substrate for IC chip mounting with which the optical element was mounted in the position, and a multilayer printed wiring board with which optical waveguide was formed in the position, its connection loss between the mounted optics is low, and excellent in connection dependability as a device for optical communication.
Moreover, in the above-mentioned device for optical communication, since an optic and electronic parts required for optical communication can be unified, it can contribute to the miniaturization of the terminal equipment for optical communication.
[0015]
Moreover, in the device for optical communication of this invention, it is desirable to form the closure resin layer between the substrate for IC chip mounting and a multilayer printed wiring board. Since dust, a foreign matter, etc. which are floating the inside of air do not enter between an optical element and optical waveguide and transmission of a lightwave signal is not checked with this dust, foreign matter, etc. when the closure resin layer is formed, it will excel with the dependability as a device for optical communication.
[0016]
Furthermore, since the duty with which this closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board can be achieved when the closure resin layer is formed, fracture near the solder bump which connects the substrate for IC chip mounting and a multilayer printed wiring board etc. can be prevented. Moreover, when the above-mentioned closure resin layer is formed, it is harder to generate location gap of an optical element and optical waveguide, and transmission of the lightwave signal between an optical element and optical waveguide is not checked, either.
Therefore, when a closure resin layer is formed between the substrate for IC chip mounting, and a multilayer printed wiring board also from such a point, it will excel with the dependability as a device for optical communication.
[0017]
Moreover, as for the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, in the device for optical communication of this invention, connecting electrically through a solder bump is desirable. It is because both can be more certainly stationed to a position according to the self-alignment operation which solder has.
In addition, it is thought that it happens in order that the surface tension which is going to become a globular form when solder is attached to a metal, while the operation which is going to exist in a stable configuration by near the center of opening for solder bump formation with the fluidity to which self has [solder] a self-alignment operation at the time of reflow processing is said and, as for this operation, solder is crawled by the solder resist layer may work strongly.
Though location gap has occurred to both in front of a reflow in case the above-mentioned substrate for IC chip mounting is connected on the above-mentioned multilayer printed wiring

board through the above-mentioned solder bump when this self-alignment operation is used, the above-mentioned substrate for IC chip mounting can move at the time of a reflow, and this substrate for IC chip mounting can be attached in the exact location on the above-mentioned multilayer printed wiring board.
therefore, if it is alike, respectively and optics, such as a photo detector, a light emitting device, and optical waveguide, are attached in the exact location, the device for optical communication which is excellent in connection dependability can be manufactured by [of the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board] connecting the above-mentioned substrate for IC chip mounting on the above-mentioned multilayer printed wiring board through a solder bump.
[0018]
Hereafter, the device for optical communication of this invention is explained, referring to a drawing.
Drawing 1 is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention. In addition, the device for optical communication in the condition that IC chip was mounted is shown in drawing 1 R> 1.
[0019]
As shown in drawing 1 , the device 150 for optical communication consists of a substrate 120 for IC chip mounting, and a multilayer printed wiring board 100, and the substrate 120 for IC chip mounting and the multilayer printed wiring board 100 are electrically connected through the solder connection (not shown).
Moreover, the closure resin layer 160 is formed between the substrate 120 for IC chip mounting, and the multilayer printed wiring board 100.
In addition, the IC chip 140 is mounted in the substrate 120 for IC chip mounting through the solder connection 143.
[0020]
the substrate 1100 top for optical element insertion which has an optical element mounting field in the substrate 120 for IC chip mounting -- both sides of a substrate 1121 -- a conductor -- the conductor whose substrate 1121 pinched while laminating formation of circuits 1124 and 1125 and the resin insulating layer 1122 between layers was carried out -- the conductor with which it was connected by the through hole 1129 and circuits sandwiched the resin insulating layer 1122 between layers further -- the laminating of the package substrate 1120 to which circuits were connected by the Bahia hall 1127 is carried out.
the substrate 1100 for optical element insertion -- both sides of a substrate 1101 -- a conductor -- a circuit forms -- having -- this -- a conductor -- the through hole 1106 which connects between circuits is formed, and the resin filler layer 1110 forms this through hole 1106 in that interior -- having -- further -- the resin filler layer 1110 -- a wrap -- the lid plating layer 1116 is formed like.
[0021]
Moreover, the substrate 1100 for optical element insertion has the field for optical element mounting in the center of abbreviation. While the optical element of a photo detector 1138 and a light emitting device 1139 is arranged in this field for optical element mounting using the resin for die bondings (not shown), the resin packed bed 1141 for optical paths is formed, and the above-mentioned optical element is electrically connected with the metal layer 1136 of the package substrate 1120 by wirebonding through a wire 1140. In addition, it may replace with the resin for die bondings, a conductive paste may be used for arrangement of an optical element, and solder may be used for it depending on the case.
In addition, in the substrate 120 for IC chip mounting, the resin packed bed 1141 for optical paths, an optical element (a photo detector 1138 and light emitting device 1139), and the field that a wire 1140 occupies are equivalent to the field for optical element mounting.
Moreover, although the above-mentioned resin packed bed for optical paths may consist of one layer as shown in drawing 1 , it may consist of two-layer [of the resin packed bed for inner layer optical paths, and the resin packed bed for outer layer optical paths], and may consist of three or more layers, for example. This is explained in full detail behind.

[0022]
Moreover, in the device 150 for optical communication shown in drawing 1 , as an optical element, although the optical element of a wirebonding mold is used, the optical element used in the device for optical communication of this invention may be the thing of a flip chip mold.
In addition, what is necessary is to prepare the pad for optical element connection in the package substrate beforehand, and just to attach an optical element here through solder, in using the optical element of a flip chip mold.
Moreover, what is necessary is just to specifically [it is desirable to carry out the resin seal of the gap of this optical element and a package substrate, and] carry out a resin seal with the resin constituent for forming the resin layer for inner layer optical paths etc., when the optical element of a flip chip mold is attached.
[0023]
The solder resist layer 1134 to which the substrate 120 for IC chip mounting has opening in the outermost layer by the side of the package substrate 1120 is formed, and the solder bump for mounting IC chip in opening of the solder resist layer 1134 through the solder pad (metal layer) 1136 is formed. In addition, as mentioned above, the device for optical communication with which the IC chip 140 was mounted through the solder connection 143 is shown in drawing 1 .
[0024]
moreover, the multilayer printed wiring board 100 -- both sides of a substrate 101 -- a conductor -- the conductor with which laminating formation was carried out and the substrate 101 of the resin insulating layer [a circuit 104 and] 102 between layers was pinched -- the conductor which sandwiched circuits and the resin insulating layer 102 between layers -- circuits are electrically connected by the through hole 109 and the Bahia hall 107, respectively.
Moreover, the resin filler layer 110 is formed in the through hole 109.
Furthermore, while the solder resist layer 114 which equipped the mounting substrate 120 for IC chip of a multilayer printed wiring board 100 and the outermost layer of the side which counters with the opening 111 for optical paths is formed, the optical waveguide 118 (118a, 118b) equipped with the optical-path conversion mirror 119 (119a, 119b) is formed directly under [for optical paths] opening 111, and the resin layer 108 for optical paths is formed in the opening 111 for optical paths.
[0025]
In the device 150 for optical communication which consists of such a configuration the lightwave signal sent from the outside through an optical fiber (not shown) etc. introduces into optical waveguide 118a -- having -- optical-path conversion mirror 119a and the opening 111 for optical paths -- further after being sent to a photo detector 1138 (light sensing portion 1138a) through the closure resin layer 160 and the resin packed bed 1141 for optical paths, it changes into an electrical signal by the photo detector 1138 -- having -- further -- a conductor -- it will be sent to the IC chip 140 through a circuit and a solder connection.
[0026]
Moreover, the electrical signal sent out from the IC chip 140 a solder connection and a conductor, after being sent to a light emitting device 1139 through a circuit And it optical-path conversion mirror 119b Minds, and is introduced into optical waveguide 118b. it changes into a lightwave signal by the light emitting device 1139 -- having -- this lightwave signal -- the resin packed bed 1141 for optical paths from a light emitting device 1139 (light-emitting part 1139a), the closure resin layer 160, and opening 111for optical paths b -- further it is delivery outside as a lightwave signal through an optical fiber (not shown) etc. -- it will be carried out.
[0027]
In such a device for optical communication of this invention, since an optic and electronic parts required for optical communication can be unified while the transmission distance of an electrical signal is short and can respond to a high-speed communication link more in the location near the inside of the substrate for IC chip mounting, i.e., IC chip, since light / electrical signal conversion is performed, it can contribute to the miniaturization of the terminal equipment for optical communication.
[0028]

moreover, at the above-mentioned device for optical communication, the electrical signal sent out from IC chip is delivery outside through an optical fiber etc., after being changed into a lightwave signal, as mentioned above -- it is not only carried out, but it sends to a multilayer printed wiring board through a solder bump -- having -- the conductor of this multilayer printed wiring board -- it will be sent to electronic parts (not shown), such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included).
In addition, although the solder bump who connects the substrate for IC chip mounting and a multilayer printed wiring board is not illustrated with the sectional view of the device 150 for optical communication shown in drawing 1 , both are connected in fact through the solder bump who formed in the substrate for IC chip mounting, and/or the multilayer printed wiring board.
[0029]
Moreover, in the device 150 for optical communication shown in drawing 1 , the closure resin layer 160 is formed between the substrate 120 for IC chip mounting, and the multilayer printed wiring board 100. Thus, since dust, a foreign matter, etc. which are floating the inside of air do not enter between an optical element and optical waveguide and transmission of a lightwave signal is not checked by existence of dust or a foreign matter, the device for optical communication with which the closure resin layer is formed between the substrate for IC chip mounting and the multilayer printed wiring board will be more excellent in dependability.
[0030]
As the above-mentioned closure resin layer, especially if there is little absorption by the communication link wavelength range, it will not be limited, but as the ingredient, thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was sensitization-ized, ultraviolet curing mold resin, etc. are mentioned, for example. In these, thermosetting resin is desirable.
Specifically, the polymer manufactured from silicone resin; benz-cyclo-butene, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned.
[0031]
Moreover, as for the above-mentioned closure resin layer, it is desirable for the permeability of communication link wavelength light to be 70% or more.
At less than 70%, the transmission of communication link wavelength light has large loss of a lightwave signal, and is because it may lead to the fall of the dependability of the device for optical communication. As for the above-mentioned permeability, it is more desirable that it is 90% or more.
When consisting only of a resinous principle which the above-mentioned closure resin layer mentioned above especially, as for the permeability, it is desirable that it is 90% or more, and when the particle is blended with the closure resin layer so that it may mention later, as for the permeability, it is desirable that it is 70% or more.
[0032]
In addition, in this specification, the permeability of communication link wavelength light means the permeability of the communication link wavelength light per die length of 1mm. When the light of I1 carried out incidence to the above-mentioned closure resin layer in strength, passing this closure resin layer 1mm, and having come out, and the intensity of light which came out is I2, it is specifically the value computed by the following formula (1).
[0033]
Permeability (%) =(I2/I1) x100 ... (1)
[0034]
In addition, the above-mentioned permeability means the permeability measured at 25-30 degrees C.
[0035]
Moreover, it is desirable to contain particles, such as a resin particle, an inorganic particle, and metal particles, in the above-mentioned closure resin layer.

By including a particle, it is because it is harder coming to generate the crack which could be made to adjust a coefficient of thermal expansion between the above-mentioned substrate for IC chip mounting, or the above-mentioned multilayer printed wiring board, and originated in the difference of a coefficient of thermal expansion.
[0036]
In the device for optical communication of this invention which consists of a substrate for IC chip mounting, and a multilayer printed wiring board in addition, the coefficient of thermal expansion (the direction of the z-axis) of the configuration member A substrate For example, 5.0x10-5 - 6.0x10-5 (/degree C) extent, The resin insulating layer between layers 6.0x10-5 - 8.0x10-5 (/degree C) extent, 0.1x10-5 - 1.0x10-5 (/degree C) extent and a closure resin layer 0.1x10-5 - 100x10-5 (/degree C) extent, [a particle] The closure resin layer which blended the particle 3.0x10-5 - 4.0x10-5 (/degree C) extent, an optical element made from IC chip, silicon, germanium, etc. -- 0.5x10-5 - 1.5x10-5 (/degree C) extent and a conductor -- a circuit is 1.0x10-5 - 2.0x10-5 (/degree C) extent. In addition, the measurement temperature of the above-mentioned coefficient of thermal expansion is 20 degrees C.
Thus, if the particle is blended with the closure resin layer, the difference of the coefficient of thermal expansion of this closure resin layer and other configuration members which constitute the device for optical communication will become small. Therefore, stress will be eased. Moreover, when the particle is blended with the closure resin layer, it is harder coming to generate location gap of an optical element and optical waveguide.
[0037]
Moreover, when blending a particle with the above-mentioned closure resin layer, the comparable thing of the refractive index of the resinous principle of this closure resin layer and the refractive index of the above-mentioned particle is desirable. Therefore, when blending a particle with a closure resin layer, it is desirable to mix two or more kinds of particles from which a refractive index differs, and to make it the refractive index of a particle become comparable as the refractive index of a resinous principle.
When a resinous principle is the epoxy resin of a refractive index 1.53, specifically, it is desirable for the silica particle and refractive index of 1.54 to mix the titania particle of 1.52, and for a refractive index to use.
In addition, after melting and mixing the approach and two or more sorts of particles to knead as an approach of mixing a particle, the approach of making it into the shape of a particle etc. is mentioned.
[0038]
What consists of resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, thermosetting resin, and thermoplastics, complex of a photopolymer and thermoplastics, etc. as the above-mentioned resin particle, for example is mentioned.
[0039]
Specifically For example, an epoxy resin, phenol resin, polyimide resin, Thermosetting resin, such as a bismaleimide resin, polyphenylene resin, polyolefin resin, and a fluororesin; The heat-curing radical of these thermosetting resin A methacrylic acid, an acrylic acid, etc. are made to react to (for example, the epoxy group in an epoxy resin). Resin which gave the acrylic radical; Phenoxy resin, polyether sulfone (PES), Thermoplastics, such as polysulfone (PSF), a polyphenylene sulfone (PPS), polyphenylene sulfide (PPES), a polyphenyl ether (PPE), and polyether imide (PI); what consists of photopolymers, such as acrylic resin, etc. is mentioned.
Moreover, what consists of resin complex of the resin complex of the above-mentioned thermosetting resin and the above-mentioned thermoplastics, the resin which gave the above-mentioned acrylic radical, the above-mentioned photopolymer, and the above-mentioned thermoplastics can also be used.
Moreover, the resin particle which consists of rubber can also be used as the above-mentioned resin particle.
[0040]
Moreover, as the above-mentioned inorganic particle, what consists of titanium compounds, such

as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, and basic magnesium carbonate, a silica, and a zeolite, and a titania, etc. is mentioned, for example. Moreover, what was made to mix and carry out melting of a silica and the titania at a fixed rate, and was equalized may be used.
Moreover, what consists of Lynn or phosphorus compounds can also be used as the above-mentioned inorganic particle.
[0041]
As the above-mentioned metal particles, what consists of gold, silver, copper, palladium, nickel, platinum, iron, zinc, lead, aluminum, magnesium, calcium, etc. is mentioned, for example.
These resin particles, an inorganic particle, and metal particles may be used independently, and may be used together two or more sorts.
[0042]
Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in a closure resin layer.
furthermore, that the configuration of the above-mentioned particle is spherical or an ellipse -- when spherical, it will be hard to reflect light by this particle, and loss of a lightwave signal will be reduced.
[0043]
Moreover, the minimum with a desirable particle size of the above-mentioned particle is 0.01 micrometers, and a more desirable minimum is 0.1 micrometers. On the other hand, the upper limit with the above-mentioned desirable particle size is 100 micrometers, a more desirable upper limit is 50 micrometers, and, as for especially the upper limit, it is desirable that it is shorter than communication link wavelength. It is because a possibility that transmission of a lightwave signal may be checked more will decrease if the mean particle diameter of the above-mentioned particle is shorter than communication link wavelength.
Moreover, as long as it is the particle which has the particle size of this range, the particle of two or more kinds of different particle size may be included.
In addition, in this specification, the particle size of a particle means the die length of the longest part of a particle.
[0044]
The minimum with the desirable loadings of the particle contained in the above-mentioned closure resin layer is 10 % of the weight, and a more desirable minimum is 20 % of the weight. On the other hand, the upper limit with the desirable loadings of the above-mentioned particle is 80 % of the weight, and a more desirable upper limit is 70 % of the weight. It is because transmission of a lightwave signal may be checked when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight cannot fully be acquired and the loadings of a particle exceed 80 % of the weight.
In addition, what is necessary is just to choose the concrete presentation suitably so that a closure resin layer may fill the low loss nature of a lightwave signal, and the outstanding thermal resistance and crack-proof nature in order that the presentation of the above-mentioned closure resin layer may affect dependability, such as transmission loss of a lightwave signal, thermal resistance, and flexural strength.
[0045]
In the device for optical communication of this invention, it is desirable for the refractive index of the above-mentioned resin packed bed for optical paths and the refractive index of the above-mentioned closure resin layer to be the same. for example, when the refractive index of the above-mentioned resin packed bed for optical paths is smaller than the refractive index of the above-mentioned closure resin layer The lightwave signal which the lightwave signal transmitted through the resin packed bed for optical paths will condense toward the light sensing portion of a

photo detector, and was sent out from the above-mentioned light emitting device It will originate in both refractive indexes of what will be refracted in the direction which does not spread in the interface of the resin packed bed for optical paths and a closure resin layer differing, and reflection of a lightwave signal will occur in the interface of the resin packed bed for optical paths, and a closure resin layer, consequently the transmission loss of a lightwave signal becomes large. Therefore, in order to make transmission loss of a lightwave signal small, it will be desirable for the refractive index of the resin packed bed for optical paths and the refractive index of the above-mentioned closure resin layer to be the same, and it will usually choose both refractive index suitably in consideration of the degree of reflection of the lightwave signal in the interface of the resin packed bed for optical paths, and a closure resin layer, and the degree of refraction.

[0046]

Moreover, it is desirable to form the resin layer for optical paths in the above-mentioned device for optical communication in opening for optical paths prepared in the multilayer printed wiring board, and it is desirable for the refractive index of the above-mentioned resin layer for optical paths and the refractive index of a closure resin layer to be the same in this case. When both refractive index is the same, it is because transmission loss of a lightwave signal can be made small like the case where the refractive index of the resin packed bed for optical paths and the refractive index of a closure resin layer are the same.

furthermore, when the inside of the above-mentioned opening for optical paths is an opening In the process which forms the closure resin layer at the time of the above-mentioned device manufacture for optical communication Although the resin constituent which is not hardened for forming a closure resin layer may enter in the opening of the above-mentioned opening for optical paths, a void may occur in that case and generating of such a void may have a bad influence on the lightwave signal transmission ability of the device for optical communication When the resin layer for optical paths is formed in opening for optical paths, such a problem does not occur.

[0047]

Moreover, when the resin layer for optical paths is formed in the interior of the above-mentioned opening for optical paths, the same thing of each refractive index of the above-mentioned resin packed bed for optical paths, the above-mentioned resin layer for optical paths, and the above-mentioned closure resin layer is desirable. Thus, when three persons' refractive index is the same, it is because reflection of a lightwave signal does not take place by the interface of the above-mentioned resin packed bed for optical paths, and the above-mentioned closure resin layer, and the interface of the above-mentioned closure resin layer and the above-mentioned resin layer for optical paths.

[0048]

In addition, the refractive index of the resinous principle used for the above-mentioned closure resin layer or the resin packed bed for optical paths 1.50 to about 1.60 and acrylic resin 1.40 to about [for example,] 1.55 [an epoxy resin] As an approach of polyolefine being 1.55 to about 1.65 and adjusting refractive indexes, such as the above-mentioned closure resin layer For example, by fluorinating a part of resinous principle, or phenyl-izing, by changing polarizability or deuterating a part of resinous principle, molecular weight is changed and the method of changing the refractive index of a resinous principle etc. is mentioned. In addition, such an adjustment approach of a refractive index can be used also as an approach of adjusting the refractive index of optical waveguide.

[0049]

Moreover, in the above-mentioned device for optical communication, it is desirable to arrange at least one micro lens in the multilayer printed wiring board of the above-mentioned resin packed bed for optical paths and the field which counters.

Drawing 2 is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.

The device 250 for optical communication shown in drawing 2 consists of a substrate 220 for IC chip mounting, and a multilayer printed wiring board 200 as well as the device 150 for optical

communication shown in drawing 1 , and the closure resin layer 260 is formed between the substrate 220 for IC chip mounting, and the multilayer printed wiring board 200.
Moreover, in the substrate 220 for IC chip mounting, it is between an optical element (a light emitting device 2138 and photo detector 2139) and the optical-path conversion mirror 219, and the micro lens 2246 is arranged in the closure resin layer 260 of the resin packed bed 2141 for optical paths, and the field (a multilayer printed wiring board 200 and field which counters) which counters. Thus, a lightwave signal can be more certainly transmitted by arranging a micro lens between an optical element (a photo detector and light emitting device) and optical waveguide.
In addition, although it is desirable to be arranged in two between a light emitting device and an optical-path conversion mirror and between a photo detector and an optical-path conversion mirror as for the above-mentioned micro lens as shown in drawing 2 , it may be arranged only in either depending on the case.
[0050]
In addition, the operation gestalt of the device 250 for optical communication shown in drawing 2 is the same as the operation gestalt of the device 150 for optical communication, except that the micro lens 246 is arranged in the closure resin layer 160 of the resin packed bed 2141 for optical paths of the substrate 220 for IC chip mounting, and the field which counters.
[0051]
Moreover, as for the closure resin layer of the above-mentioned resin packed bed for optical paths, and the refractive index of the micro lens arranged in the field (a multilayer printed wiring board and field which counters) which counters, it is desirable that it is larger than the refractive index of the above-mentioned closure resin layer. Since a lightwave signal can be made to condense towards desired by arranging the micro lens which has such a refractive index, transmission of a lightwave signal can be ensured.
[0052]
Moreover, when the above-mentioned micro lens is a convex configuration lens which has a convex only on one side (closure resin layer side) as shown in drawing 2 , the radius of curvature of the above-mentioned micro lens is suitably chosen in consideration of the focal distance of the above-mentioned micro lens. In specifically making radius of curvature small when lengthening the focal distance of a micro lens, and shortening a focal distance, it enlarges radius of curvature.
[0053]
Moreover, although illustration has not been carried out, when the resin layer for optical paths is formed in the interior of opening for optical paths of a multilayer printed wiring board, it is desirable to arrange the micro lens also in the edge by the side of the closure resin layer of this opening for optical paths, and it is desirable for the refractive index of a micro lens to be larger than the refractive index of the above-mentioned closure resin layer in this case.
[0054]
The micro lens is arranged also in the edge of opening for optical paths. Moreover, and the distance from the light sensing portion of the above-mentioned photo detector, or the light-emitting part of the above-mentioned light emitting device to the front face of the above-mentioned resin packed bed for optical paths, the thickness of opening for optical paths by which the resin layer for optical paths was formed in the interior -- abbreviation -- the refractive index of the micro lens arranged in the edge of opening for optical paths when the same, and the closure resin layer of the resin packed bed for optical paths and the refractive index of the micro lens arranged in the field which counters -- abbreviation -- the same thing is desirable.
Since a lightwave signal can be condensed towards desired by arranging the micro lens which has such a refractive index, transmission of a lightwave signal can be ensured.
[0055]
It is not limited especially as the above-mentioned micro lens, but what is used for the optical lens is mentioned, and optical glass, the resin for optical lenses, etc. are mentioned as an example of the quality of the material.
As the above-mentioned resin for optical lenses, the polymer manufactured from silicone resin; benz-cyclo-butene, such as polyimide resin; epoxy resin;UV hardenability epoxy resin;

deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned, for example.
[0056]
When arranging a micro lens in the closure resin layer of the above-mentioned resin packed bed for optical paths, and the field which counters, this micro lens may be arranged through the transparent adhesives layer by the resin packed bed for optical paths, and may be directly arranged by this resin packed bed for optical paths.
In addition, that what is necessary is just to arrange in the edge of opening for optical paths through a transparent adhesives layer similarly when arranging a micro lens in the edge of opening for optical paths, when the resin layer for optical paths is formed in the interior of opening for optical paths, it may be directly arranged by this resin layer for optical paths.
[0057]
As for the above-mentioned micro lens, it is desirable to be attached so that the core of a micro lens may be located on the straight line which connects the light sensing portion of a photo detector, the light-emitting part of a light emitting device, and the optical-path conversion mirror of optical waveguide.
Moreover, the configuration of the above-mentioned micro lens is not necessarily limited to the lens of a convex configuration as shown in drawing 2 , and is just condensed towards a request of a lightwave signal.
[0058]
The operation gestalt of the substrate for IC chip mounting which constitutes the device for optical communication of this invention is not limited to the gestalt shown in drawing 1 or 2. Drawing 3 is the sectional view showing typically another operation gestalt of the device for optical communication of this invention.
[0059]
In the substrate 120 for IC chip mounting with which the device 350 for optical communication shown in drawing 3 also consists of a substrate 320 for IC chip mounting, and a multilayer printed wiring board 300, and constitutes the device 150 for optical communication which the structure of the substrate for IC chip mounting shows to drawing 1 , although it differs, other structures etc. are the device 150 for optical communication shown in drawing 1 , and abbreviation identitas. Therefore, suppose that only the substrate 320 for IC chip mounting which constitutes the device 350 for optical communication is explained to a detail here.
[0060]
the substrate 3100 top for optical element insertion with which the substrate 320 for IC chip mounting has a field for optical element mounting -- both sides of a substrate 3121 -- a conductor -- the conductor with which laminating formation was carried out and the substrate 3121 of the resin insulating layer [circuits 3124 and 3125 and] 3122 between layers pinched -- the conductor with which it was connected by the through hole 3129 and circuits sandwiched the resin insulating layer 3122 between layers -- the laminating of the package substrate 3120 to which between circuits was connected by the Bahia hall is carried out.
[0061]
Moreover, the substrate 3100 for optical element insertion has the field for optical element mounting in that center of abbreviation, while the optical element of a photo detector 3138 and a light emitting device 3139 is arranged in this field for optical element mounting, the resin packed bed for optical paths (resin packed bed 3141for inner layer optical paths a, resin packed bed 3141for outer layer optical paths b) is formed in it, and the above-mentioned optical element is electrically connected with the metal layer 3136 of the package substrate 3120 by wirebonding through a wire 3140.
Moreover, the pad for electrical connection of the photo detector 3138 shown in drawing 3 and a light emitting device 3139 (part linked to the wire of an optical element) is prepared in the package substrate side rather than each light sensing portion 3138a and light-emitting part 3139a.
since a connection with the above-mentioned wire and the wire of the above-mentioned optical

element can be protected by the resin packed bed for inner layer optical paths by making structure of the resin packed bed for optical paths into the structure which consists of two-layer [of the resin packed bed for inner layer optical paths, and the resin packed bed for outer layer optical paths] using the optical element of such a configuration -- an optical element and a conductor -- connection dependability with a circuit (metal layer) will be more excellent.

[0062]

Moreover, in the substrate 320 for IC chip mounting, the through hole 3106 which penetrates the substrate 3100 for optical element insertion and the package substrate 3120 is formed, and the resin filler layer 3110 is formed in the interior. Moreover, the solder resist layer 3134 which has opening is formed in the outermost layer of the side in which the substrate 320 for IC chip mounting mounts IC chip, and the solder bump 3143 for mounting IC chip is formed in opening of the solder resist layer 3134 through the solder bump (metal layer) 3136.

[0063]

Next, other configuration members of the device for optical communication of this invention etc. are explained.

The optical element (a photo detector, light emitting device) is mounted in the substrate for IC chip mounting which constitutes the device for optical communication of this invention.

As the above-mentioned photo detector, PD (photodiode), APD (avalanche photodiode), etc. are mentioned, for example.

What is necessary is just to use these properly suitably in consideration of the configuration of the above-mentioned device for optical communication, demand characteristics, etc.

Si, germanium, InGaAs, etc. are mentioned as an ingredient of the above-mentioned photo detector.

In these, a point to InGaAs which is excellent in light-receiving sensibility is desirable.

[0064]

As the above-mentioned light emitting device, LD (semiconductor laser), DFB-LD (distribution feedback mold-semiconductor laser), LED (light emitting diode), etc. are mentioned, for example.

What is necessary is just to use these properly suitably in consideration of a configuration, demand characteristics, etc. of the above-mentioned device for optical communication.

[0065]

As an ingredient of the above-mentioned light emitting device, a gallium, arsenic and the compound (GaAsP) of Lynn, a gallium, aluminum and the compound (GaAlAs) of arsenic, a gallium and the compound (GaAs) of arsenic, an indium, a gallium and the compound (InGaAs) of arsenic, an indium, a gallium, arsenic, the compound (InGaAsP) of Lynn, etc. are mentioned.

That what is necessary is just to use these properly in consideration of communication link wavelength, when communication link wavelength is 0.85-micrometer band, GaAlAs can be used, and in the case of 1.3-micrometer band or 1.55-micrometer band, communication link wavelength can use InGaAs and InGaAsP.

[0066]

Moreover, the resin packed bed for optical paths is formed in the substrate for IC chip mounting which constitutes the device for optical communication of this invention, and a lightwave signal can be transmitted to it between the optical element mounted in the above-mentioned substrate for IC chip mounting through this resin packed bed for optical paths, and the optical waveguide formed in the above-mentioned multilayer printed wiring board.

[0067]

The above-mentioned resin packed bed for optical paths may consist of one layer like drawing 1 and the resin packed beds 1141 and 2141 for optical paths shown in 2, and may consist of two-layer [of resin packed bed 3141a for inner layer optical paths, and resin packed bed 3141b for outer layer optical paths] like the resin packed bed for optical paths shown in drawing 3 .

When the above-mentioned resin packed bed for optical paths consisted of two-layer, the dependability as a device for optical communication should be excelled more by forming the resin packed bed for inner layer optical paths using the resin constituent suitable for fixing an optical element, and forming the resin packed bed for outer layer optical paths using the resin constituent which is excellent in the transmission of communication link wavelength light.

Moreover, when forming the resin packed bed for inner layer optical paths and the resin packed bed for outer layer optical paths from which a property differs in this way, the thickness of this resin packed bed for inner layer optical paths will be the same as the thickness of the above-mentioned optical element, or will be thinner than it. It is because transmission of a lightwave signal may be checked when the thickness of the resin packed bed for inner layer optical paths which carries out A of the above-mentioned property is thicker than the thickness of the above-mentioned optical element.
In addition, the above-mentioned resin packed bed for optical paths may consist of three or more layers depending on the case.
[0068]
When the above-mentioned resin packed bed for optical paths consists of one layer, this resin packed bed for optical paths will not be limited especially if excelled in the permeability of communication link wavelength light, but the resin constituent which uses as a resinous principle thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, these complex, etc. as the ingredient, for example is mentioned.
As an example of the above-mentioned resinous principle, an epoxy resin, phenol resin, polyimide resin, olefine resin, BT resin, etc. are mentioned, for example.
[0069]
Moreover, particles, such as for example, a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned resin constituent in addition to the above-mentioned resinous principle. By including these particles, adjustment of a coefficient of thermal expansion can be aimed at between the resin packed bed for optical paths, a substrate and a solder resist layer, the resin insulating layer between layers, etc., and fire retardancy can also be given depending on the class of particle.
As an example of the above-mentioned particle, the same thing as the particle contained in the above-mentioned closure resin layer etc. is mentioned, for example.
[0070]
Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned.
Moreover, the minimum with a desirable particle size (the die length of the longest part of a particle) of the above-mentioned particle is 0.01 micrometers, and a more desirable minimum is 0.1 micrometers. On the other hand, the upper limit with the above-mentioned desirable particle size is 100 micrometers, a more desirable upper limit is 50 micrometers, and, as for especially the upper limit, it is desirable that it is shorter than communication link wavelength. It is because a possibility that transmission of a lightwave signal may be checked more will decrease if the mean particle diameter of the above-mentioned particle is shorter than communication link wavelength.
[0071]
Moreover, when the above-mentioned resin packed bed for optical paths consists of two-layer [of the resin packed bed for inner layer optical paths, and the resin packed bed for outer layer optical paths], the resin constituent which is excellent in the permeability of the lightwave signal mentioned above as an ingredient of the resin packed bed for outer layer optical paths can be used, and the same thing as the ingredient of the well-known resin for IC chip closures etc. can be used for example, conventionally as an ingredient of the resin packed bed for inner layer optical paths.
The resin constituent which specifically contains the resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, thermosetting resin, and thermoplastics, the complex of a photopolymer and thermoplastics, etc. is mentioned.
As an example, as a filler, a silica etc. is blended with phenol novolak system resin as a curing agent, it is blended with the epoxy resin of a cresol novolak system, and the resin constituent with which the additive of others, such as a reaction accelerator, a coupling agent, a flame retarder (fire-resistant assistant), and a coloring agent, was blended is mentioned further if

needed, for example.
[0072]
In the above-mentioned substrate for IC chip mounting, when the above-mentioned resin packed bed for optical paths consists of one layer, as for the permeability of this resin packed bed for optical paths, it is desirable that it is 70% or more, and it is more desirable that it is 90% or more. In addition, in this specification, the permeability of the resin packed bed for optical paths means the permeability of the communication link wavelength light per die length of 1mm. When the light of I3 carried out incidence to the above-mentioned resin packed bed for optical paths in strength, passing this resin packed bed for optical paths, and having come out, and the intensity of light which came out is I4, it is specifically the value computed by following (2).
[0073]
Permeability (%) =(I4/I3) x100 ... (2)
[0074]
In addition, the above-mentioned permeability means the permeability measured at 25-30 degrees C.
[0075]
Moreover, when the above-mentioned resin packed bed for optical paths consists of two-layer, it is desirable for the permeability (permeability of the communication link wavelength light per die length of 1mm) of the resin packed bed for the upper optical paths to be 70% or more, and it is more desirable that it is 90% or more.
[0076]
Moreover, optical waveguide is formed in the multilayer printed wiring board which constitutes the device for optical communication of this invention.
The inorganic system optical waveguide which consists of the organic system optical waveguide and quartz glass which consist of a polymer ingredient etc., a compound semiconductor, etc. as the above-mentioned optical waveguide, for example is mentioned. In these, the organic system optical waveguide which consists of a polymer ingredient etc. is desirable. It is because it excels in adhesion with the resin insulating layer between layers and processing is easy.
[0077]
The complex of the resin and thermosetting resin with which it was not limited as the above-mentioned polymer ingredient especially when there was little absorption by the communication link wavelength range, for example, some of thermosetting resin, thermoplastics, photopolymers, and thermosetting resin were photosensitivity-ized, and thermoplastics, the complex of a photopolymer and thermoplastics, etc. are mentioned.
[0078]
Specifically, silicone resin, such as polyimide resin, such as acrylic resin, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, and fluorination polyimide, an epoxy resin, UV hardenability epoxy resin, polyolefine system resin, and deuteration silicone resin, the polymer manufactured from benz-cyclo-butene are mentioned.
[0079]
Particles, such as for example, a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned optical waveguide in addition to the above-mentioned resinous principle.
The thing same as an example of the above-mentioned particle as the particle contained in the above-mentioned closure resin layer etc. is mentioned.
[0080]
Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in optical·waveguide. furthermore, that the configuration of the above-mentioned particle is spherical or an ellipse -- when spherical, it will be hard to reflect light by this particle, and loss of a lightwave signal will be reduced.
[0081]

Moreover, the minimum with a desirable particle size of the above-mentioned particle is 0.01 micrometers, and a more desirable minimum is 0.1 micrometers. On the other hand, the upper limit with the above-mentioned desirable particle size is 100 micrometers, a more desirable upper limit is 50 micrometers, and, as for especially the upper limit, it is desirable that it is shorter than communication link wavelength. It is because a possibility that transmission of a lightwave signal may be checked more will decrease if the mean particle diameter of the above-mentioned particle is shorter than communication link wavelength.
Moreover, as long as it is the particle which has the particle size of this range, the particle of two or more kinds of different particle size may be contained.
[0082]
The minimum with the desirable loadings of the particle contained in the above-mentioned optical waveguide is 10 % of the weight, and a more desirable minimum is 20 % of the weight. On the other hand, the upper limit with the desirable loadings of the above-mentioned particle is 80 % of the weight, and a more desirable upper limit is 70 % of the weight. It is because transmission of a lightwave signal may be checked when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be acquired and the loadings of a particle exceed 80 % of the weight.
Moreover, although especially the configuration of the above-mentioned optical waveguide is not limited, since the formation is easy, the shape of a sheet is desirable.
[0083]
Thus, when a particle is contained in optical waveguide, adjustment of a coefficient of thermal expansion can be aimed at between optical waveguide, the substrate which constitutes a multilayer printed wiring board, the resin insulating layer between layers, etc., and it is harder coming to generate a crack, exfoliation, etc. resulting from the difference of a coefficient of thermal expansion.
[0084]
Moreover, the thickness of the above-mentioned optical waveguide has desirable 1-100 micrometers, and the width of face has desirable 1-100 micrometers. the conductor which constitutes a multilayer printed wiring board if the above-mentioned width of face is not sometimes easy for the formation in less than 1 micrometer and the above-mentioned width of face exceeds 100 micrometers on the other hand -- it may become the cause which checks the degree of freedom of designs, such as a circuit
[0085]
Moreover, the ratio of the thickness of the above-mentioned optical waveguide and width of face has a desirable way near 1:1. This is usually because the flat-surface configuration of the light sensing portion of the above-mentioned photo detector or the light-emitting part of the above-mentioned light emitting device is a circle configuration. In addition, especially the ratio of the above-mentioned thickness and width of face is not limited, and should just usually be about 1:2 - about 2:1 abbreviation.
Furthermore, when the above-mentioned optical waveguide is the optical waveguide of the single mode which is the communication link wavelength of 1.55 micrometers, as for the thickness and width of face, it is desirable that it is 5-15 micrometers, and when the above-mentioned optical waveguide is the optical waveguide of a multimode on the communication link wavelength of 0.85 micrometers, it is desirable [the thickness and width of face] that it is 20-80 micrometers.
[0086]
Moreover, as the above-mentioned optical waveguide, it is desirable to form the optical waveguide for light-receiving and the optical waveguide for luminescence. In addition, the above-mentioned optical waveguide for light-receiving means the optical waveguide for transmitting the lightwave signal sent from the outside through an optical fiber etc. to a photo detector, and the above-mentioned optical waveguide for luminescence means the optical waveguide for transmitting the lightwave signal sent from the light emitting device to an optical fiber etc.
Moreover, it is desirable for the above-mentioned optical waveguide for light-receiving and the above-mentioned optical waveguide for luminescence to be what consists of the same ingredient. It is because adjustment of a coefficient of thermal expansion etc. is easy for a scale

or the formation to like.
[0087]
It is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide, as mentioned above. By forming an optical-path conversion mirror, it is because it is possible to change an optical path into a desired include angle.
Formation of the above-mentioned optical-path conversion mirror can be performed by cutting the end of optical waveguide so that it may mention later.
[0088]
In addition, in the multilayer printed wiring board shown in drawing 1 -3, although optical waveguide is formed on the resin insulating layer between layers of the substrate for IC chip mounting, and the outermost layer of the side which counters, the formation location of the optical waveguide in the device for optical communication of this invention may not necessarily be limited here, may be between the resin insulating layers between layers, and may be between a substrate and the resin insulating layer between layers. Furthermore, you may be between the resin insulating-layer top between layers of the outermost layer of the opposite side whose substrate was pinched the substrate for IC chip mounting, and the side which counters, and between the resin insulating layers between layers, a substrate, and the resin insulating layers between layers etc.
[0089]
Moreover, although optical waveguide is formed on the resin insulating layer between layers of the outermost layer, and the solder resist layer is further formed in the multilayer printed wiring board shown in drawing 1 -3 so that this resin insulating layer between layers and optical waveguide may be covered This solder resist layer does not necessarily need to be formed, for example, optical waveguide was formed on [of the outermost layer / whole] the resin insulating layer between layers, and this optical waveguide may play a role of a solder resist layer.
The device for optical communication of this invention which consists of such a configuration can be manufactured by the manufacture approach of the device for optical communication of this invention mentioned later, for example.
[0090]
Next, the manufacture approach of the device for optical communication of this invention is explained.
After the manufacture approach of the device for optical communication of this invention manufactured separately the substrate for IC chip mounting which has at least the field for optical element mounting where an optical element is mounted, and in which the resin packed bed for optical paths was both formed, and the multilayer printed wiring board with which optical waveguide was formed at least,
Between the optical element of the above-mentioned substrate for IC chip mounting, and the optical waveguide of the above-mentioned multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal, and it fixes to it,
Furthermore, after slushing the resin constituent for the closures between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, it is characterized by forming a closure resin layer by performing hardening processing.
[0091]
By the manufacture approach of the device for optical communication of this invention, since a closure resin layer be form among both after arrange and fix the substrate for IC chip mounting, and a multilayer printed wiring board to a position, the device for optical communication with which dust, a foreign matter, etc. which be float the inside of air do not enter between an optical element and optical waveguide, and transmission of a lightwave signal be check can be manufacture suitably.
[0092]
Moreover, it is harder it coming to generate location gap of an optical element and optical waveguide in the obtained device for optical communication by being able to achieve the duty with which this closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for

IC chip mounting, and the above-mentioned multilayer printed wiring board, and forming a closure resin layer by forming a closure resin layer between the substrate for IC chip mounting, and a multilayer printed wiring board.
Therefore, by the manufacture approach of this invention, the device for optical communication which is excellent in dependability can be manufactured suitably.
[0093]
By the manufacture approach of the above-mentioned device for optical communication, the substrate for IC chip mounting and a multilayer printed wiring board are manufactured separately first.
Therefore, suppose that the manufacture approach of the substrate for IC chip mounting and the manufacture approach of a multilayer printed wiring board are explained separately, and how to form a closure resin layer is explained after that first here.
[0094]
First, the manufacture approach of the substrate for IC chip mounting is explained.
Manufacture of the above-mentioned substrate for IC chip mounting performs both by passing through lamination and a further predetermined process, after producing separately for example, a package substrate and the substrate for optical element insertion. Therefore, how to produce the substrate for optical element insertion and the approach of producing a package substrate are first explained separately in order of a process, respectively, and the process which sticks both and is used as the substrate for IC chip mounting is explained after that.
[0095]
Production of a package substrate can be performed by passing through the process of for example, following (A) - (C).
(A) first -- a substrate top -- a conductor -- form a circuit.
performing etching processing, after forming a solid conductor layer by nonelectrolytic plating processing etc. on a substrate and specifically forming a resist on this conductor layer -- a substrate top -- a conductor -- a circuit is formed.
moreover, the thing for which plating resist is formed on a substrate and plating processing and exfoliation of plating resist are performed after that -- a substrate top -- a conductor -- a circuit may be formed.
[0096]
As the above-mentioned substrate, the substrate with which reinforcing materials, such as a glass fiber, consist of resin (for example, glass epoxy resin) with which it sank in, FR-4 substrate, FR-5 substrate, etc. are mentioned to an epoxy resin, polyester resin, polyimide resin, bismaleimide-triazine resin (BT resin), phenol resin, and these resin, for example.
Moreover, a double-sided copper-clad laminated circuit board, an one side copper-clad laminated circuit board, a RCC substrate, etc. may be used as a substrate with which the solid conductor layer was formed.
in addition, a conformal substrate and the substrate formed with the additive process -- a conductor -- you may use as a substrate with which the circuit was formed.
[0097]
moreover, the conductor whose above-mentioned substrate was pinched if needed -- the through hole which connects between circuits may be formed.
the case where a through hole is formed -- for example, the thing, for which a conductor layer is formed also in the wall surface of a through tube in case the through tube is formed in the substrate by drilling, the lasing, etc. and a solid conductor layer is formed beforehand, before forming a solid conductor layer, and etching processing is performed after that -- a conductor -- what is necessary is just to form a through hole, while forming a circuit
moreover, the thing for which nonelectrolytic plating processing etc. is performed to the wall surface of this through tube, and etching processing is further performed to a conductor layer after forming a through tube in the substrate with which the solid conductor layer was formed beforehand -- a conductor -- a circuit and a through hole may be formed.
[0098]
Moreover, when a through hole is formed, it is desirable to be filled up with a resin filler in this

through hole. In addition, restoration of a resin filler can lay on a substrate the mask with which opening was formed in the part equivalent to a through hole, and can be performed using a squeegee.
[0099]
moreover, a conductor -- roughening formation processing may be performed to a circuit front face (the land front face of a through hole is included). a conductor -- it is because adhesion with the resin insulating layer between layers which carries out laminating formation at a back process by making a circuit front face into a roughening side can be raised.
as the above-mentioned roughening formation processing -- melanism (oxidization) -- the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. are mentioned.
In addition, before this roughening formation processing is filled up with a resin filler in a through hole, it may be performed, and it may form a roughening side also in the wall surface of a through hole. It is because the adhesion of a through hole and a resin filler improves.
[0100]
As a resin filler with which it is filled up in the above-mentioned through hole, the resin constituent containing an epoxy resin, a curing agent, and an inorganic particle etc. is mentioned, for example.
Although not limited especially as the above-mentioned epoxy resin, a kind is [choose / from the group which consists of a bisphenol mold epoxy resin and a novolak mold epoxy resin] desirable in it being few.
It is because a novolak mold epoxy resin is excellent in thermal resistance or chemical resistance with high intensity, the viscosity can be prepared even if a diluent solvent is not used for a bisphenol mold epoxy resin by choosing the resin of A mold or a female mold, it is not disassembled even if it is among strong base nature solutions, such as nonelectrolytic plating liquid, and it is hard to carry out a pyrolysis.
[0101]
As the above-mentioned bisphenol mold epoxy resin, the bisphenol A mold epoxy resin and a bisphenol female mold epoxy resin are desirable, and the point which is hypoviscosity and can be used with a non-solvent to a bisphenol female mold epoxy resin is more desirable.
Moreover, as the above-mentioned novolak mold epoxy resin, a kind is [choose / from a phenol novolak mold epoxy resin and a cresol novolak mold epoxy resin] desirable in it being few.
[0102]
Moreover, a bisphenol mold epoxy resin and a cresol novolak mold epoxy resin may be mixed and used. In this case, as for the mixed ratio of a bisphenol mold epoxy resin and a cresol novolak mold epoxy resin, it is desirable that it is 1 / 1 - 1/100 in a weight ratio.
[0103]
It is not limited especially as a curing agent contained in the above-mentioned resin filler, a well-known curing agent can be used conventionally, for example, an imidazole system curing agent, an acid-anhydride curing agent, an amine system curing agent, etc. are mentioned. In these, an imidazole system curing agent is desirable and liquefied 1-benzyl-2-methylimidazole, and 1-cyanoethyl-2-ethyl-4-methylimidazole and a 4-methyl-2-ethyl imidazole are desirable in 25 degrees C especially.
[0104]
Moreover, as an inorganic particle contained in the above-mentioned resin filler, what consists of titanium compounds, such as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, basic magnesium carbonate, and talc, a silica, and a zeolite, and a titania, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts.
Moreover, coating of the above-mentioned inorganic particle may be carried out by the silane coupling agent etc. It is because the adhesion of an inorganic particle and an epoxy resin

improves.
[0105]
Moreover, the minimum with the desirable content ratio in the resin constituent of the above-mentioned inorganic particle is 10 % of the weight, and a more desirable minimum is 20 % of the weight. Moreover, the upper limit with the above-mentioned desirable content ratio is 80 % of the weight, and a more desirable upper limit is 70 % of the weight. It is because adjustment of a coefficient of thermal expansion can be aimed at between substrates etc.
[0106]
Moreover, especially the configuration of the above-mentioned inorganic particle is not limited, but the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of the shape of a ball or an ellipse ball is desirable. It is because generating of the crack resulting from the configuration of a particle etc. can be controlled.
The mean particle diameter of the above-mentioned inorganic particle has desirable 0.01-5.0 micrometers.
[0107]
Moreover, in the above-mentioned resin constituent, other thermosetting resin, thermoplastics, etc. may be contained in addition to the above-mentioned epoxy resin etc.
As the above-mentioned thermosetting resin, polyimide resin, phenol resin, etc. are mentioned, for example. As the above-mentioned thermoplastics For example, a polytetrafluoroethylene (PTFE) and ethylene tetrafluoride 6 fluoride propylene copolymer (FEP), Fluororesins, such as an ethylene tetrafluoride perphloro alkoxy copolymer (PFA), Polyethylene terephthalate (PET), polysulfone (PSF), A polyphenylene sulfide (PPS), thermoplastic mold polyphenylene ether (PPE), Polyether sulfone (PES), polyether imide (PEI), polyphenylene sulfone (PPES), polyethylenenaphthalate (PEN), a polyether ether ketone (PEEK), polyolefine system resin, etc. are mentioned. These may be used independently and may use two or more sorts together.
In addition, it may replace with the above-mentioned epoxy resin, and these resin may be used.
[0108]
(B) next, a conductor -- while forming the resin insulating layer between layers which has the Bahia hall on the substrate in which the circuit was formed -- this resin insulating-layer top between layers -- a conductor -- form a circuit.
concrete -- for example, the following -- passing through the process of (i) - (vi) -- the resin insulating layer between layers, and a conductor -- formation with a circuit is performed.
[0109]
(i) -- first -- a conductor -- the resin layer which forms the non-hardened resin layer which consists of thermosetting resin or resin complex on the substrate in which the circuit was formed, or consists of thermoplastics is formed.
The resin layer which is not hardened [above-mentioned] may apply non-hardened resin by the roll coater, curtain coater, etc., may fabricate it, and may carry out thermocompression bonding of the resin film non-hardened (semi-hardening), and may form it. Furthermore, the resin film with which metal layers, such as copper foil, were formed in one side of a non-hardened resin film may be stuck.
Moreover, as for the resin layer which consists of thermoplastics, it is desirable to form by carrying out thermocompression bonding of the resin Plastic solid fabricated in the shape of a film.
[0110]
In applying the resin which is not hardened [above-mentioned], it performs heat-treatment, after applying resin.
Heat curing of the non-hardened resin can be carried out by performing the above-mentioned heat-treatment.
In addition, the above-mentioned heat curing may be performed after forming opening for the Bahia halls mentioned later.
[0111]
As an example of the thermosetting resin used in formation of such a resin layer, an epoxy resin,

phenol resin, polyimide resin, polyester resin, a bismaleimide resin, polyolefine system resin, polyphenylene ether resin, etc. are mentioned, for example.
[0112]
As the above-mentioned epoxy resin, a cresol novolak mold epoxy resin, the bisphenol A mold epoxy resin, a bisphenol female mold epoxy resin, a phenol novolak mold epoxy resin, an alkylphenol novolak mold epoxy resin, a biphenol female mold epoxy resin, a naphthalene mold epoxy resin, a dicyclopentadiene mold epoxy resin, the epoxidation object of the condensate of phenols and the aromatic aldehyde which has a phenolic hydroxyl group, triglycidyl isocyanurate, cycloaliphatic epoxy resin, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Thereby, it excels in thermal resistance etc.
[0113]
As the above-mentioned polyolefine system resin, the copolymer of polyethylene, polystyrene, polypropylene, a polyisobutylene, polybutadiene, polyisoprene, cycloolefin system resin, and these resin etc. is mentioned, for example.
[0114]
Moreover, as the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, etc. are mentioned, for example.
Moreover, as complex (resin complex) of thermosetting resin and thermoplastics, especially if thermosetting resin and thermoplastics are included, it will not be limited, but as the example, the resin constituent for roughening side formation etc. is mentioned, for example.
[0115]
That by which the matter of fusibility was distributed to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer into the heat-resistant-resin matrix which is not hardened [poorly soluble] to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer as the above-mentioned resin constituent for roughening side formation, for example is mentioned.
In addition, when the same time amount immersion is carried out, the word of the above "poor solubility" and "fusibility" says relatively what has an early dissolution rate as "fusibility" to the same roughening liquid for convenience, and calls "poor solubility" relatively what has a late dissolution rate to it for convenience.
[0116]
In case the above-mentioned roughening liquid is used for the resin insulating layer between layers and a roughening side is formed as the above-mentioned heat-resistant-resin matrix, what can hold the configuration of a roughening side is desirable, for example, thermosetting resin, thermoplastics, these complex, etc. are mentioned. Moreover, you may be a photopolymer. In the process which forms opening for the Bahia halls mentioned later, it is because opening can be formed by the exposure development.
[0117]
As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyolefin resin, a fluororesin, etc. are mentioned, for example. Moreover, the resin which made the heat-curing radical acrylic(meta)--ization-react to these thermosetting resin using the resin which gave photosensitivity, i.e., a methacrylic acid, an acrylic acid, etc., may be used. The acrylate (meta) of an epoxy resin is desirable and, specifically, the epoxy resin which has two or more epoxy groups in 1 molecule is more more desirable still.
[0118]
As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, polyphenylene sulfone, polyphenylene sulfide, a polyphenyl ether, polyether imide, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.
[0119]
As matter of the above-mentioned fusibility, an inorganic particle, a resin particle, metal particles, a rubber particle, liquid phase resin, liquid phase rubber, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.
[0120]

As the above-mentioned inorganic particle, the particle which consists of titanium compounds [, such as a silicon compound; titania,], such as magnesium compound; silicas, such as potassium compound; magnesias [, such as lime compound; potassium carbonate,], such as aluminium compound; calcium carbonates, such as an alumina and an aluminum hydroxide, and a calcium hydroxide, a dolomite, basic magnesium carbonate, and talc, and a zeolite, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts.
Dissolution removal of the above-mentioned alumina particle can be carried out by fluoric acid, and dissolution removal of the calcium carbonate can be carried out with a hydrochloric acid. Moreover, dissolution removal of a sodium content silica or the dolomite can be carried out in an alkali water solution.
[0121]
As the above-mentioned resin particle, what consists of thermosetting resin, thermoplastics, etc. is mentioned, for example. When immersed in the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer It will not be limited especially if a dissolution rate is earlier than the above-mentioned heat-resistant-resin matrix. Specifically For example, what consists of amino resin (melamine resin, a urea-resin, guanamine resin, etc.), an epoxy resin, phenol resin, phenoxy resin, polyimide resin, polyphenylene resin, polyolefin resin, a fluororesin, bismaleimide-triazine resin, etc. is mentioned. These may be used independently and may be used together two or more sorts.
In addition, the above-mentioned resin particle needs to carry out hardening processing beforehand. It is because the above-mentioned resin particle dissolves in the solvent in which a resin matrix is dissolved, so homogeneity will be mixed and dissolution removal only of the resin particle can be alternatively carried out neither with an acid nor an oxidizer, unless it makes it harden.
[0122]
As the above-mentioned metal particles, what consists of gold, silver, copper, tin, zinc, stainless steel, aluminum, nickel, iron, lead, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts.
Moreover, the surface may be covered with resin etc. in order that the above-mentioned metal particles may secure insulation.
[0123]
(ii) Next, in forming the resin insulating layer between layers using thermosetting resin and resin complex as the ingredient, while performing hardening processing to a non-hardened resin layer, opening for the Bahia halls is formed and it considers as the resin insulating layer between layers.
As for the above-mentioned opening for the Bahia halls, forming by the lasing is desirable. The above-mentioned lasing may be performed before the above-mentioned hardening processing, and may be performed after hardening processing.
Moreover, when the resin insulating layer between layers which consists of a photopolymer is formed, opening for the Bahia halls may be prepared by performing exposure and a development. In addition, exposure and a development are performed before the above-mentioned hardening processing in this case.
[0124]
Moreover, when forming the resin insulating layer between layers using thermoplastics as the ingredient, opening for the Bahia halls can be formed in the resin layer which consists of thermoplastics by the lasing, and it can consider as the resin insulating layer between layers.
[0125]
At this time, carbon dioxide gas laser, excimer laser, UV laser, an YAG laser, etc. are mentioned as laser to be used, for example. These may be properly used in consideration of the configuration of opening for the Bahia halls to form etc.
[0126]
When forming the above-mentioned opening for the Bahia halls, much openings for the Bahia halls can be formed at once by irradiating the laser beam by the excimer laser of a hologram method through a mask.

Moreover, when opening for the Bahia halls is formed using the carbon dioxide gas laser of a short pulse, there is little resin remainder in opening and the damage to the resin of an opening periphery is small.
[0127]
Moreover, when irradiating a laser beam through an optical-system lens and a mask, much openings for the Bahia halls can be formed at once.
By minding an optical-system lens and a mask, it is the same reinforcement and is because whenever [illuminating-angle] can irradiate the same laser beam at coincidence at two or more parts.
[0128]
(iii) Next, a roughening side is formed in the front face of the resin insulating layer between layers including the wall of opening for the Bahia halls using an acid or an oxidizer if needed.
In addition, this roughening side is formed in order to raise the adhesion of the resin insulating layer between layers, and the thin film conductor layer formed on it, and when there is adhesion sufficient between the resin insulating layer between layers and a thin film conductor layer, it is not necessary to form it.
[0129]
As the above-mentioned acid, a sulfuric acid, a nitric acid, a hydrochloric acid, a phosphoric acid, formic acid, etc. are mentioned, and permanganates, such as a chromic acid, chromate acid mixture, and sodium permanganate, etc. are mentioned as the above-mentioned oxidizer.
Moreover, after forming a roughening side, it is desirable to neutralize the front face of the resin insulating layer between layers using water solutions, neutralization liquid, etc., such as alkali.
It is because it can avoid having effect of an acid or an oxidizer on degree process.
Moreover, formation of the above-mentioned roughening side may be performed using plasma treatment etc.
[0130]
Moreover, the maximum roughness Rmax of the above-mentioned roughening side has desirable 0.1-20 micrometers. if Rmax exceeds 20 micrometers -- the roughening side itself -- damage and exfoliation -- winning popularity -- easy -- Rmax -- less than 0.1 micrometers -- a conductor -- it is because adhesion with a circuit cannot fully be acquired. especially -- a semiadditive process -- a conductor -- when forming a circuit, the above-mentioned maximum roughness Rmax has desirable 0.1-5 micrometers. While adhesion with a thin film conductor layer is fully securable, it is because removal of a thin film conductor layer is easy.
[0131]
(iv) Next, a thin film conductor layer is formed in the front face of the resin insulating layer between layers which prepared opening for the Bahia halls.
The above-mentioned thin film conductor layer is formed using approaches, such as nonelectrolytic plating, sputtering, and vacuum evaporationo. In addition, when a roughening side is not formed in the front face of the resin insulating layer between layers, as for the above-mentioned thin film conductor layer, forming by sputtering is desirable.
In addition, in forming a thin film conductor layer with nonelectrolytic plating, it gives the catalyst beforehand to the galvanized front face. As the above-mentioned catalyst, a palladium chloride etc. is mentioned, for example.
[0132]
Although especially the thickness of the above-mentioned thin film conductor layer is not limited, when this thin film conductor layer is formed with nonelectrolytic plating, 0.6-1.2 micrometers is desirable, and when it forms by sputtering, 0.1-1.0 micrometers is desirable.
Moreover, as the quality of the material of the above-mentioned thin film conductor layer, Cu, nickel, P, Pd, Co, W, etc. are mentioned, for example. In these, Cu and nickel are desirable.
[0133]
(v) Next, a dry film is used for the part on the above-mentioned thin film conductor layer, plating resist is formed, after that, electrolysis plating is performed by making the above-mentioned thin film conductor layer into a plating bar, and an electrolysis plating layer is formed in the above-mentioned plating-resist agenesis section.

[0134]
Moreover, opening for the Bahia halls is filled up with this process with electrolysis plating, and it is good also considering the structure of the Bahia hall as field beer structure, and the Bahia hall which has a hollow is once formed in that top face, this hollow is filled up with a conductive paste after that, and it is good also as field beer structure. Moreover, after forming in a top face the Bahia hall which has a hollow, the hollow is filled up with a resin filler etc., a lid plating layer is further formed on it, and it is good also as a Bahia hall where a top face is flat. The Bahia hall can be formed in right above [of the Bahia hall] by making structure of the Bahia hall into field beer structure.
[0135]
(vi) -- the conductor which exfoliated plating resist, removed further the thin film conductor layer which existed under plating resist by etching, and became independent -- it considers as a circuit. As an etching reagent, persulfate water solutions, such as a sulfuric-acid-hydrogen-peroxide-solution solution and ammonium persulfate, a ferric chloride, a cupric chloride, a hydrochloric acid, etc. are mentioned, for example. Moreover, the mixed solution containing the second copper complex mentioned above as an etching reagent and an organic acid may be used.
[0136]
in addition, the conductor indicated here -- the conductor in the manufacture approach of this invention although the formation approach of a circuit is an additive process -- the formation approach of a circuit may not necessarily be limited to an additive process, for example, may be a subtractive process.
the following and a subtractive process -- a conductor -- how to form a circuit is explained briefly.
[0137]
First, the resin insulating layer between layers which has opening for the Bahia halls is formed like the process of the above (i) - (iii), and a thin film conductor layer is further formed in the front face of the resin insulating layer between layers containing the wall surface of opening for the Bahia halls like the process of the above (iv).
[0138]
Next, thickness of a conductor layer is thickened by forming an electroplating layer etc. the whole surface on the above-mentioned thin film conductor layer. In addition, what is necessary is just to perform formation of an electroplating layer etc. if needed.
Subsequently, etching resist is formed on the above-mentioned conductor layer.
After the above-mentioned etching resist sticks for example, a photosensitive dry film, it carries out adhesion arrangement of the photo mask on this photosensitive dry film, and forms it by performing an exposure development.
[0139]
furthermore, the conductor which became independent on the resin insulating layer between layers by etching processing removing the above-mentioned etching-resist agenesis subordinate's conductor layer, and exfoliating etching resist after that -- a circuit (the Bahia hall is included) is formed.
In addition, the above-mentioned etching processing can be performed using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, and exfoliation of etching resist can be performed using an alkali water solution etc.
[0140]
while forming the resin insulating layer between layers which has the Bahia hall by using such an approach -- the resin insulating-layer top between layers -- a conductor -- a circuit can be formed. In addition, in the substrate for IC chip mounting of this invention, although the resin insulating layer between layers forms only one layer, it may carry out laminating formation of the resin insulating layer between layers more than two-layer by repeating this process (B) two or more times depending on the substrate for IC chip mounting to manufacture.
[0141]

moreover, a conductor -- or [whether an additive process is chosen as the formation approach of a circuit, or / choosing a subtractive process] -- a conductor -- ** is good if it chooses suitably in consideration of numbers, pitches, etc. of a connection terminal, such as the width of face and spacing of a circuit, IC chip to mount, and an optical element, other various electronic parts.
[0142]
(C) Next, form a solder resist layer in the outermost layer.
After applying a non-hardened solder resist constituent by the roll coater, curtain coater, etc. or specifically sticking by pressure the solder resist constituent fabricated in the shape of a film, a solder resist layer is formed by performing hardening processing.
[0143]
The above-mentioned solder resist layer can be formed using the solder resist constituent containing for example, polyphenylene ether resin, polyolefin resin, a fluororesin, thermoplastic elastomer, an epoxy resin, polyimide resin, etc.
[0144]
moreover, as solder resist constituents other than the above For example, the acrylate (meta) of a novolak mold epoxy resin, an imidazole curing agent, 2 functionality (meta) acrylic ester monomer, the polymer of with a molecular weight of about 500 to 5000 acrylic ester (meta), The fluid of the shape of a paste containing photosensitive monomers, such as thermosetting resin which consists of a bisphenol mold epoxy resin etc., and a multiple-valued acrylic monomer, a glycol ether system solvent, etc. is mentioned, and, as for the viscosity, it is desirable to be adjusted to 1 - 10 Pa-s at 25 degrees C.
Moreover, as for the above-mentioned solder resist constituent, the elastomer and the inorganic filler may be blended.
Moreover, a commercial solder resist constituent may be used as a solder resist constituent.
[0145]
Moreover, opening is formed in the above-mentioned solder resist layer by the lasing or the exposure development if needed. Under the present circumstances, the same thing as the laser used in case opening for the Bahia halls mentioned above is formed as laser to be used etc. is mentioned.
[0146]
next, the conductor exposed to the base of the above-mentioned opening -- a metal layer is formed on the surface of a circuit if needed. In addition, the metal layer formed in opening at this process may play a role of a solder pad, when the solder resist layer which has this opening constitutes the outermost layer of the substrate for IC chip mounting.
the above-mentioned metal layer -- corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, -- the above -- a conductor -- it can form by covering a circuit front face. Specifically, it is desirable to form with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold.
Moreover, although the above-mentioned solder pad can be formed using approaches, such as plating, vacuum evaporationo, and electrodeposition, in these, the point of excelling in the homogeneity of an enveloping layer to its plating is desirable.
Moreover, the mark for alignment used at the process mentioned later in the case of lamination with the substrate for optical element insertion may be formed in the solder resist layer formed at this process.
Such (A) A package substrate is producible by passing through the process of - (C).
[0147]
Next, the production approach of the substrate for optical element insertion is explained.
Production of the substrate for optical element insertion can be performed by passing through the process of for example, following (a) - (c).
(a) first -- both sides or one side of a substrate -- nonelectrolytic plating processing etc. -- a conductor -- form a circuit.
performing etching processing, after forming a solid conductor layer by nonelectrolytic plating processing etc. on a substrate and specifically forming a resist on this conductor layer -- a

substrate top -- a conductor -- a circuit is formed.
moreover, the thing for which plating resist is formed on a substrate and plating processing and exfoliation of plating resist are performed after that -- a substrate top -- a conductor -- a circuit may be formed.
[0148]
moreover, the conductor whose substrate was pinched at this process -- the through hole which connects between circuits may be formed.
forming a conductor layer also in the wall surface of a through tube, in case the through tube is formed in the substrate by drilling, the lasing, etc. and a solid conductor layer is formed, and performing etching processing after that beforehand, before formation of a through hole forms a solid conductor layer for example, by nonelectrolytic plating processing etc. -- a conductor -- a through hole may be formed while forming a circuit.
moreover, the thing for which nonelectrolytic plating processing etc. is performed to the wall surface of this through tube, and etching processing is further performed to a conductor layer after forming a through tube in the substrate with which the solid conductor layer was formed beforehand -- a conductor -- a circuit and a through hole may be formed.
[0149]
moreover, the thing which plating resist is formed in a part of front face of a substrate, and a conductor layer is formed in the wall surface and the plating-resist agenesis section of a through tube after that, and is further exfoliated in plating resist after forming a through tube in a substrate -- a conductor -- a circuit and a through hole may be formed.
Moreover, before forming a conductor layer after forming a through tube in forming a through tube in a substrate by these approaches, it is desirable to perform DESUMIA processing to this through tube. For example, using oxidizers, such as permanganic acid and chromic acid, as the above-mentioned DESUMIA processing drug solution processing, dry processing using the plasma, etc. are mentioned.
[0150]
The same thing as the substrate used as a substrate used here, for example in case a package substrate is produced etc. is mentioned.
Moreover, also in the process which produces this substrate for optical element insertion, when the above-mentioned through hole is formed, it is desirable for it to be filled up with a resin filler and to form a resin filler layer in this through hole. In addition, restoration of a resin filler can lay on a substrate the mask with which opening was formed in the part equivalent to a through hole, and can be performed using a squeegee.
Moreover, also in this process, before being filled up with a resin filler in a through hole, it is desirable to form a roughening side in the wall surface of a through hole. Thereby, it is because the adhesion of a through hole and a resin filler layer improves more.
The same thing as the resin filler used as the above-mentioned resin filler, for example when forming a package substrate etc. can be used.
[0151]
moreover, this conductor -- in a circuit formation process, after forming a resin filler layer in a through hole, a wrap lid plating layer may be formed for the exposure from the through hole of this resin filler layer. It is because it becomes possible to form a solder pad by forming a lid plating layer not only the land top of a through hole but on a lid plating layer, so the degree of freedom of a design improves more.
[0152]
After the above-mentioned lid plating layer forms a conductor layer in the front face of the substrate containing the exposure of for example, a resin filler layer and forms etching resist in a lid plating stratification part, it performs etching processing, or forms plating resist in the lid plating layer agenesis part beforehand, and can form it by performing plating processing and removal of plating resist.
[0153]
therefore, the thing processed in the following procedure in this process when forming a lid plating layer on a through hole -- a conductor -- formation of a circuit and a through hole and

formation of a lid plating layer can be performed to coincidence.
That is, first, after forming a through tube in a substrate, a conductor layer is formed in the front face of the substrate containing the wall surface of this through tube, and, subsequently to the wall surface, it is filled up with a resin filler in the through tube in which the conductor layer was formed. furthermore, the conductor after carrying out laminating formation of the conductor layer by plating processing etc. on the conductor layer formed in the exposure and substrate front face of a resin filler -- carrying out etching removal of the conductor layer of the circuit agenesis section and the through hole agenesis section -- a conductor -- formation of a circuit and a through hole and formation of a lid plating layer can be performed to coincidence.
[0154]
(b) next, a conductor -- the conductor on the substrate in which the circuit was formed -- form an adhesives layer in a part of circuit agenesis section [at least]. in addition, this specification -- setting -- the land part of a through hole -- a conductor -- it shall contain in a circuit therefore, the land part of a through hole -- a conductor -- it is not equivalent to the circuit agenesis section.
the near conductor stuck with a package substrate at a back process in this process -- an adhesives layer is formed in all or a part of circuit agenesis sections. What is necessary is just to apply the above-mentioned adhesives layer so that sufficient adhesive property with a package substrate may be acquired. Therefore, it is ** [it may form an adhesives layer in the part which forms a through tube at the process of (c) mentioned later].
[0155]
As the above-mentioned adhesives, thermosetting resin, thermoplastics, a photopolymer, the resin with which a part of heat-curing radical was sensitization-ized, the thing which consists of these complex can be used, for example.
As an example, an epoxy resin, phenol resin, polyimide resin, BT resin, etc. are mentioned, for example. Moreover, the adhesives fabricated in the shape of a sheet may be used beforehand, and prepreg may be used.
[0156]
(c) Form a through tube in some substrates which formed the adhesives layer next. In the through tube formed here, an optical element will be arranged in a back process.
For example, router processing etc. can perform formation of the above-mentioned through tube.

Moreover, although especially the formation location of the above-mentioned through tube is not limited, it is usually formed in the center of a substrate.
[0157]
Moreover, in this process, after forming a through tube, in order to remove the weld flash which exists in a through tube wall surface, drug solution processing, polish processing, etc. may be performed.
The above-mentioned drug solution processing can be performed using the oxidizer which consists of water solutions, such as a chromic acid and a permanganate.
Such (a) The substrate for optical element insertion is producible by passing through the process of - (c).
[0158]
Next, after sticking the substrate for optical element insertion produced through the process of the package substrate produced through the process of - (C), and (above-mentioned A) above-mentioned (a) - (c) through the adhesives layer which this substrate for optical element insertion has, how to use as the substrate for IC chip mounting is explained.
[0159]
Lamination of a package substrate and the substrate for optical element insertion can be performed using for example, a pin lamination method, a mass lamination method, etc.
After performing both alignment, specifically, a package substrate and the substrate for optical element insertion are stuck by carrying out a temperature up to the temperature (usually about 60-200 degrees C) which an adhesives layer softens, and subsequently pressing by the pressure of 1 - 10MPa extent. Then, it considers as the substrate for IC chip mounting through the

process of following the (1) - (3).
[0160]
(1) the conductor of the above-mentioned optical element after attaching an optical element in the front face of the package substrate first exposed from the through tube formed in the above-mentioned substrate for optical element insertion, and the above-mentioned package substrate -- connect a circuit electrically.
What is necessary is just to choose suitably installation of the above-mentioned optical element, and the approach of electric connection according to an optical element.
Hereafter, the case where the optical element of a wirebonding mold is used, and the case where the optical element of a flip chip mold is used are explained concretely.
[0161]
When using the optical element of a wirebonding mold, installation of an optical element can be performed by for example, the eutectic joining-together method, the solder joining-together method, a resin bond method, etc. Moreover, an optical element may be attached using a silver paste metallurgy paste.
By the describing [above] resin bond method, thermosetting resin, such as epoxy system resin and polyimide system resin, is used as base resin, the paste which contains a curing agent, a filler, a solvent, etc. in addition to these resinous principles is applied on a package substrate, and subsequently to a paste top, after laying an optical element, an optical element is attached by carrying out heat hardening of this paste.
In addition, spreading of the above-mentioned paste can be performed with for example, the dispensing method, the ************ing method, screen printing, etc.
Moreover, in using a silver paste, a silver paste is applied on a package substrate, and after laying an optical element, subsequently to a paste top, it attaches an optical element by calcinating this ****-strike.
[0162]
Wirebonding is electrically used for connection for the above-mentioned optical element and the metal layer of the above-mentioned package substrate. Connection of the optical element by wirebonding has the large degree of freedom of the design at the time of attaching, and it is economically advantageous.
As the above-mentioned wirebonding, a well-known approach, i.e., the nail-head-bonding method and the wedge bonding method, can be used conventionally.
[0163]
Moreover, when using the optical element of a flip chip mold, installation of an optical element and electric connection can be made to coincidence. In addition, as the approach of flip chip bonding, a well-known approach can be used conventionally.
Moreover, when using the optical element of a flip chip mold as an optical element, it is desirable to carry out the resin seal of the gap of this optical element and the above-mentioned package substrate.
In addition, in case a resin seal forms the resin packed bed for optical paths for example, at a back process, it fills up coincidence with a resin constituent in the gap of an optical element and a package substrate, and should just perform it by carrying out hardening processing after that.
Of course, a resin seal may be performed apart from the process which forms the resin packed bed for optical paths.
In addition, electric connection of an optical element is necessarily limited to neither wirebonding nor flip chip bonding, for example, may be performed using tape automated bonding etc.
[0164]
(2) Next, in the through tube formed in the above-mentioned substrate for optical element insertion, it is filled up with a resin constituent and form the resin packed bed for optical paths.
It is not limited especially as an approach filled up with a resin constituent, for example, approaches, such as printing and potting, can be used. Moreover, it may be filled up with what was made into the shape of a tablet using a plunger. Moreover, after being filled up with a resin constituent, hardening processing etc. is performed if needed.
[0165]

Moreover, when the above-mentioned resin packed bed for optical paths consists of more than two-layer (for example, when consisting of a resin packed bed for inner layer optical paths, and a resin packed bed for outer layer optical paths), a resin constituent will be filled up with this process in 2 steps.
furthermore, in performing hardening processing to the resin constituent filled with the process formed in the resin packed bed for optical paths which consists of more than two-layer After this hardening processing is filled up with the resin constituent used as the resin packed bed for inner layer optical paths, it is performed once. After being filled up with both the resin constituents that become a line again with the resin constituent and the resin packed bed for outer layer optical paths which are good and turn into a resin packed bed for inner layer optical paths after being filled up with the resin constituent used as the resin packed bed for outer layer optical paths, you may carry out to coincidence. According to a resin constituent, it should just determine suitably which approach is chosen.
When hardening conditions with the resin constituent used as the resin constituent and the resin packed bed for outer layer optical paths which turn into a resin packed bed for inner layer optical paths especially differ, after being filled up with the resin constituent used as the resin packed bed for inner layer optical paths, it is desirable to perform once hardening processing and to perform restoration and hardening processing of the resin constituent used as the resin packed bed for outer layer optical paths after that. Moreover, when this approach is used, the resin constituent used as the resin constituent and the resin packed bed for outer layer optical paths used as the resin packed bed for inner layer optical paths is not mixed by that interface.
[0166]
Furthermore, it is desirable to perform polish processing to the exposure of the resin constituent exposed from the through tube at this process, and to make that exposure flat. By making an exposure flat, it is because a possibility that transmission of a lightwave signal may be checked decreases more.
Polish by buffing, a sandpaper, etc., mirror polishing, clean polish, wrapping, etc. can perform the above-mentioned polish processing. Moreover, chemical polishing using an acid, an oxidizer, a drug solution, etc. may be performed. Moreover, two or more sorts of polish processings may be performed combining these approaches.
[0167]
After forming the above-mentioned resin packed bed for optical paths, a micro lens is arranged in a part of exposure (a multilayer printed wiring board and field which counters) of this resin packed bed for optical paths if needed.
In order to arrange a micro lens in a part of exposure of the above-mentioned resin packed bed for optical paths, you may arrange in a position through the adhesives layer of transparence, and may arrange in the position of the exposure of this resin packed bed for optical paths directly.
[0168]
As an approach of arranging a micro lens in the exposure of the above-mentioned resin packed bed for optical paths directly, optimum dose dropping of the non-hardened resin for optical lenses is carried out on the resin packed bed for optical paths, and this method of performing hardening processing etc. is mentioned to the resin for optical lenses which is not hardened [which was dropped], for example.
In case optimum dose dropping of the resin for optical lenses which is not hardened [above-mentioned] is carried out on the resin packed bed for optical paths, equipments, such as a dispenser, an ink jet, a micropipette, and a micro syringe, can be used.
Since the resin for optical lenses which is not hardened [which was dropped on the resin layer for optical paths] tends to become a globular form with the surface tension using such equipment, it becomes hemispherical at the exposure of the above-mentioned resin packed bed for optical paths, and a semi-sphere-like micro lens (lens of a convex configuration) can be arranged on the resin layer for optical paths by performing hardening processing to the resin for optical lenses which is not semi-sphere-like hardened after that.
In addition, a diameter of a micro lens, a configuration of a curved surface, etc. which are formed by the approach mentioned above are controllable by adjusting the viscosity of the non-

hardened resin for optical lenses etc. suitably, taking into consideration the wettability of the resin packed bed for optical paths, and the non-hardened resin for optical lenses etc.
[0169]
Moreover, after forming the above-mentioned resin packed bed for optical paths, the through hole which penetrates the above-mentioned package substrate and the above-mentioned substrate for optical element insertion may be formed if needed.
A thin film conductor layer is formed in the exposure of the package substrate which first specifically forms the through tube for through holes which penetrates the above-mentioned package substrate and the above-mentioned substrate for optical element insertion by drilling, the lasing, etc., next contains the wall surface of this through tube for through holes, and the exposure of the substrate for optical element insertion by nonelectrolytic plating, sputtering, etc. Furthermore, after forming plating resist on the substrate with which the thin film conductor layer was formed in the front face, the through hole which penetrates the above-mentioned package substrate and the above-mentioned substrate for optical element insertion is formed by forming an electrolysis plating layer in this plating-resist agenesis section, and removing the thin film conductor layer under the above-mentioned plating resist and this plating resist after that.
[0170]
As the quality of the material of the above-mentioned thin film conductor layer, copper, nickel, tin, zinc, cobalt, a thallium, lead, etc. are mentioned, for example.
In these, what consists of the copper from a point, copper, and nickel which are excellent in an electrical property, economical efficiency, etc. is desirable.
Moreover, as thickness of the above-mentioned thin film conductor layer, when forming a thin film conductor layer with nonelectrolytic plating, 0.6-1.2 micrometers is desirable. Moreover, when forming by sputtering, 0.1-1.0 micrometers is desirable.
[0171]
As the above-mentioned electrolysis plating, copper plating is desirable and 5-20 micrometers is desirable as the thickness.
Moreover, what is necessary is just to perform removal of the above-mentioned thin film conductor layer using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, that what is necessary is just to perform removal of the above-mentioned plating resist for example, using an alkali water solution etc.
moreover, the above -- a conductor -- after forming a circuit, the catalyst on the resin insulating layer between layers may be removed using an acid or an oxidizer if needed. It is because the fall of an electrical property can be prevented.
[0172]
Moreover, after forming a through hole, it is filled up with a resin constituent in this through hole, and it is desirable by performing hardening processing if needed to form a resin filler layer after that. In addition, as the above-mentioned resin constituent, the same thing as the resin constituent used in production of a package substrate when filled up with the inside of a through hole etc. can be used, for example.
[0173]
Moreover, when a resin filler layer is formed in a through hole, a wrap lid plating layer may be formed for the surface section of a resin filler layer by performing nonelectrolytic plating etc. if needed. It is because it becomes possible to form a solder pad by forming a lid plating layer not only the land top of a through hole but on a lid plating layer, so the degree of freedom of a design improves more.
[0174]
Moreover, after replacing with the approach of forming an electrolysis plating layer after forming plating resist which was mentioned above and forming an electrolysis plating layer the whole surface on a thin film conductor layer, etching resist and a solder plating layer may be formed on an electrolysis plating layer, and you may form the through hole penetrate the above-mentioned substrate for optical element insertion, and the above-mentioned package substrate further using the approach of giving etching processing.

[0175]
In addition, after formation of the through hole explained here performs mounting of an optical element, formation of the resin packed bed for optical paths, and arrangement of a micro lens, it is not necessarily necessary to perform it, before it mounts an optical element, it may be performed, before it forms the resin packed bed for optical paths, it may be performed, and before arranging a micro lens, it may be performed.
[0176]
(3) Next, form a solder resist layer in the exposure of the above-mentioned package substrate, or the exposure of the above-mentioned substrate for optical element insertion.
After applying a non-hardened solder resist constituent by the roll coater, curtain coater, etc. or specifically sticking by pressure the solder resist constituent fabricated in the shape of a film, a solder resist layer is formed by performing hardening processing.
The same thing as the solder resist constituent used as the above-mentioned solder resist constituent, for example when producing a package substrate etc. can be used.
[0177]
In addition, in this process, it is not necessary to form a solder resist layer on the resin packed bed for optical paths formed at the process of the above (2).
Moreover, when the through hole which penetrates a package substrate and the substrate for optical element insertion in the process of the above (2) is not formed, in this process, it is not necessary to form a solder resist layer in the exposure of a package substrate. Before performing this process, it is because the solder resist layer is already formed in all the exposures of a package substrate.
[0178]
Moreover, opening for solder bump formation (opening for connecting with opening for mounting IC chip or a multilayer printed wiring board) is formed in the above-mentioned solder resist layer by the lasing or the exposure development if needed. Under the present circumstances, the same thing as the laser used in case opening for the Bahia halls mentioned above is formed as laser to be used etc. is mentioned.
[0179]
In addition, after formation of the solder resist layer explained here performs mounting (process of the above (1)) of an optical element, and formation of the resin packed bed for optical paths and arrangement (process of the above (2)) of a micro lens, it is not necessarily necessary to perform it, before it mounts an optical element, it may be performed, before it forms the resin packed bed for optical paths, it may be performed, and before arranging a micro lens, it may be performed.
In addition, as mentioned above, when forming the through hole which penetrates a package substrate and the substrate for optical element insertion, formation of the above-mentioned solder resist layer is performed after forming a through hole.
[0180]
next, the conductor exposed to the base of the above-mentioned opening for solder bump formation -- a metal layer is formed on the surface of a circuit if needed.
the above-mentioned metal layer -- corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, -- the above -- a conductor -- it can form by covering a circuit front face. Specifically, it is desirable to form with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold.
Moreover, although the above-mentioned metal layer can be formed using approaches, such as plating, vacuum evaporationo, and electrodeposition, in these, the point of excelling in the homogeneity of an enveloping layer to its plating is desirable. In addition, in case this metal layer forms a solder bump etc. at a back process, it will play a role of a solder pad.
[0181]
Furthermore, after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to opening (opening for IC chip mounting) for mounting IC chip, and opening (opening for multilayer printed wiring board connection) for connecting with a multilayer printed wiring board if needed, a solder bump is

formed by carrying out a reflow.
By forming such a solder bump, it becomes possible to mount IC chip or to connect a multilayer printed wiring board through this solder bump.
In addition, that what is necessary is just to form if needed, even if this solder bump is the case where a solder bump is not formed, she can connect these and the substrate for IC chip mounting electrically through the bump of IC chip to mount or the multilayer printed wiring board to connect.
By passing through such a process, the substrate for IC chip mounting which constitutes the device for optical communication of this invention can be manufactured.
[0182]
Next, the manufacture approach of a multilayer printed wiring board is explained.
(1) first -- the process of (A) of production of the above-mentioned package substrate -- the same -- carrying out -- both sides of a substrate -- a conductor -- the conductor which forms a circuit and whose substrate was both pinched -- form the through hole which connects between circuits. moreover -- this process -- a conductor -- a roughening side is formed in the front face of a circuit, or the wall surface of a through hole if needed.
[0183]
(2) next, the need -- responding -- the process of (B) of production of the above-mentioned package substrate -- the same -- carrying out -- a conductor -- a substrate [in which the circuit was formed] top -- the resin insulating layer between layers, and a conductor -- carry out laminating formation of the circuit.
moreover, this process of (2), i.e., the resin insulating layer between layers, and a conductor -- the process which carries out the laminating of the circuit may be performed once, and is good in a multiple-times line.
[0184]
(3) next, the conductor on the substrate for IC chip mounting, the substrate of the side which counters, or the resin insulating layer between layers -- form optical waveguide in the circuit agenesis section.
Formation of the above-mentioned optical waveguide can be performed by attaching beforehand the optical waveguide fabricated in the predetermined configuration through adhesives, when carrying out by using inorganic materials, such as quartz glass, for the ingredient.
moreover, the optical waveguide which consists of the above-mentioned inorganic material -- for example, LiNbO3 and LiTaO3 etc. -- it can form by making an inorganic material form by the liquid-phase-epitaxial method, the chemistry depositing method (CVD), a molecular beam epitaxy, etc.
[0185]
As an approach of forming the optical waveguide which consists of a polymer ingredient, for example Moreover, **1 The approach of sticking the film for optical waveguide formation beforehand fabricated in the shape of a film to mold releasing film superiors on the resin insulating layer between layers, and **2 The approach of forming direct optical waveguide on the above-mentioned resin insulating layer between layers etc. is mentioned by carrying out laminating formation of a lower clad, a core, and the up clad one by one on the resin insulating layer between layers.
In addition, as the formation approach of optical waveguide, also when forming optical waveguide on a mold releasing film, and also when forming optical waveguide on the resin insulating layer between layers, it can carry out using the same approach.
Specifically, it can form using the approach using reactive ion etching, the exposure developing-negatives method, the metal mold forming method, the resist forming method, the approach that combined these.
[0186]
the approach using the above-mentioned reactive ion etching -- (i) -- first, a lower clad is formed on a mold releasing film etc., the resin constituent for cores is applied on (ii), next this lower clad, and it considers as the resin layer for core formation by performing hardening processing further if needed. (iii) Next, a mask (etching resist) is formed on the resin layer for

core formation by forming the resin layer for mask formation on the above-mentioned resin layer for core formation, and subsequently performing an exposure development to the resin layer for this mask formation.
[0187]
(iv) Next, by giving reactive ion etching to the resin layer for core formation, the resin layer for core formation of a mask agenesis part is removed, and a core is formed on a lower clad. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.
The approach using this reactive ion etching can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.
[0188]
moreover -- the exposure developing-negatives method -- (i) -- first, a lower clad is formed on a mold releasing film etc., the resin constituent for cores is applied on (ii), next this lower clad, and the layer of the resin constituent for core formation is further formed by performing semi-hardening if needed.
[0189]
(iii) Next, a core is formed on a lower clad by laying the mask with which the pattern corresponding to a core formation part was drawn on the layer of the above-mentioned resin constituent for core formation, and performing an exposure development after that. (iv) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.
Since there are few routing counters, in case this exposure developing-negatives method mass-produces optical waveguide, it can be used suitably, and since there are few heating processes, stress cannot generate it easily in optical waveguide.
[0190]
moreover -- the above-mentioned metal mold forming method -- (i) -- first, a lower clad is formed on a mold releasing film etc., and the slot for core formation is formed in (ii), next a lower clad by metal mold formation. (iii) Further, above-mentioned Mizouchi is filled up with the resin constituent for cores by printing, and a core is formed by performing hardening processing after that. (iv) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.
In case this metal mold forming method mass-produces optical waveguide, it can be used suitably, and it can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.
[0191]
moreover -- the above-mentioned resist forming method -- (i) -- first -- a mold releasing film etc. top -- a lower clad -- forming -- (ii) -- further, after applying the resin constituent for resists on this lower clad, the resist for core formation is formed in the core agenesis part on the above-mentioned lower clad by performing an exposure development.
[0192]
(iii) Next, after the resin constituent for cores applying to the resist agenesis part on a lower clad and hardening the resin constituent for cores to the (iv) pan, a core is formed on a lower clad by exfoliating the above-mentioned resist for core formation. (v) Finally, an up clad is formed on a lower clad so that the above-mentioned core may be covered, and it considers as optical waveguide.
In case this metal mold forming method mass-produces optical waveguide, it can be suitably used for this resist forming method, and it can form the optical waveguide excellent in dimension dependability. Moreover, this approach is excellent also in repeatability.
[0193]
Moreover, an optical-path conversion mirror is formed in the above-mentioned optical waveguide.
Although it may be formed before the above-mentioned optical-path conversion mirror attaches optical waveguide on the resin insulating layer between layers, and it may be formed after attaching it on the resin insulating layer between layers, it is desirable to form an optical-path

conversion mirror beforehand except for the case where this optical waveguide is directly formed on the resin insulating layer between layers. other members which can work easily and constitute a multilayer printed wiring board at the time of an activity, for example, a substrate, and a conductor -- it is because a blemish is attached to a circuit, the resin insulating layer between layers, etc. or there is no possibility of damaging these.

[0194]

It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose tip is 90 degrees of V types, processing by reactive ion etching, laser ablation, etc. can be used.

In addition, although how to form optical waveguide on the substrate of the side which counters the substrate for IC chip mounting, or the resin insulating layer between layers of the outermost layer is explained, when manufacturing the above-mentioned multilayer printed wiring board, the above-mentioned optical waveguide may be formed here between a substrate and the resin insulating layer between layers, and among the resin insulating layers between layers.

[0195]

In forming optical waveguide between a substrate and the resin insulating layer between layers the process of the above (1) -- the both sides -- a conductor, after producing the substrate with which the circuit was formed the same approach as the process of the above (3) -- the conductor on a substrate -- optical waveguide can be formed in the above-mentioned location by forming optical waveguide in a circuit agenesis part, and forming the resin insulating layer between layers by the same approach as the process of the above (2) after that.

[0196]

moreover, in forming optical waveguide among the resin insulating layers between layers the above (1) and the process of (2) -- the same -- carrying out -- a conductor, after carrying out laminating formation of the resin insulating layer between at least one-layer layers on the substrate with which the circuit was formed Optical waveguide can be formed among the resin insulating layers between layers by forming optical waveguide on the resin insulating layer between layers like the process of the above (3), and repeating the process of the above (2), and the same process after that further.

[0197]

Furthermore, it sets to the multilayer printed wiring board which constitutes the device for optical communication of this invention. In manufacturing the multilayer printed wiring board with which optical waveguide may be formed in the opposite side whose substrate was pinched the substrate for IC chip mounting, and the side which counters, and optical waveguide was formed in such a location Although it is necessary to form the optical path for lightwave signal transmission which penetrates a substrate at least so that a lightwave signal can be transmitted between the above-mentioned optical waveguide and the optical element mounted in the above-mentioned substrate for IC chip mounting What is necessary is just to form suitably such an optical path for lightwave signal transmission, before forming optical waveguide, or after forming optical waveguide.

[0198]

By passing through the above (1) and the process of (2) specifically After producing a multilayer-interconnection plate, before forming optical waveguide, the through tube for optical paths which penetrates this multilayer-interconnection plate is formed. Then, what is necessary is to form optical waveguide and just to consider as a multilayer printed wiring board through the process mentioned later further in the location which can transmit a lightwave signal between the substrates for IC chip mounting through the above-mentioned through tube for optical paths by the approach mentioned above. In addition, after forming the above-mentioned through tube for optical paths, the resin layer for optical paths and a conductor layer may be formed in the interior and wall surface if needed.

[0199]

(4) Next, form a solder resist layer in the outermost layer of the substrate in which optical waveguide was formed.

The above-mentioned solder resist layer can be formed using the resin constituent used when forming the solder resist layer of for example, the above-mentioned substrate for IC chip mounting, and the same resin constituent.
In addition, depending on the case, optical waveguide is formed in the whole outermost layer of a substrate at the process of the above (3), and you may make it optical waveguide play a role of a solder resist layer.
[0200]
(5) Next, form opening for solder bump formation (opening for mounting the substrate for IC chip mounting, and various surface mount mold electronic parts), and opening for optical paths in the substrate for IC chip mounting, and the solder resist layer of the side which counters.
Formation with the above-mentioned opening for solder bump formation and opening for optical paths can be performed to the substrate for IC chip mounting using the approach of forming opening for solder bump formation, and the same approach, i.e., an exposure development, the lasing, etc.
In addition, formation of the above-mentioned opening for solder bump formation and formation of opening for optical paths may be performed to coincidence, and are separately good in a line.
[0201]
In these, in case a solder resist layer is formed, it is desirable to choose the approach of forming opening for solder bump formation and opening for optical paths by applying the resin constituent which contains a photopolymer as the ingredient, and performing an exposure development.
It is because there is no possibility of giving a blemish to the optical waveguide which exists under this opening for optical paths, at the time of opening formation in forming opening for optical paths by the exposure development.
Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump formation and opening for optical paths may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.
In addition, in forming the through tube for optical paths and forming optical waveguide in the opposite side whose substrate was pinched the substrate for IC chip mounting, and the side which counters, in case it forms opening for optical paths at this process, it forms so that opening for optical paths may be opened for free passage with the above-mentioned through tube for optical paths.
[0202]
Moreover, opening for solder bump formation may be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and the opposite side if needed.
By passing through a back process, it is because an external connection terminal can be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and the opposite side.
[0203]
(6) next, the conductor exposed by forming the above-mentioned opening for solder bump formation -- if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a solder pad. What is necessary is just to specifically carry out using the same approach as the process of (14) of the manufacture approach of the substrate for IC chip mounting.
[0204]
(7) Next, in opening for optical paths formed at the process of the above (5), it is filled up with a non-hardened resin constituent and form the resin layer for optical paths by performing hardening processing after that if needed.
In addition, the resin constituent which is not hardened [which is filled up with this process] is the production process of the substrate for IC chip mounting, and it is desirable that it is the same as that of the resin constituent used in order to form the resin packed bed for optical paths, and the resin constituent used in order to form the resin packed bed for the upper optical paths especially.
[0205]
moreover, as mentioned above, in order to form optical waveguide in the opposite side whose

substrate was pinched the substrate for IC chip mounting, and the side which counters, when the through tube for optical paths and opening for optical paths are formed When this through tube for optical paths and this opening for optical paths may be filled up with a non-hardened resin constituent and it is filled up with the resin constituent which is not hardened [above-mentioned] here May fill up the above-mentioned through tube for optical paths, and the above-mentioned opening for optical paths at coincidence, may perform the postcure processing, and After forming the through tube for optical paths in a multilayer-interconnection plate, restoration and hardening processing of a resin constituent in which it does not harden are performed, after that, the solder resist layer which has opening for optical paths may be formed, and restoration and hardening processing of a resin constituent in which it does not harden may be performed further.

[0206]

(8) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned solder pad.

By forming such a solder bump, it becomes possible to mount the substrate for IC chip mounting, and various surface mount mold electronic parts through this solder bump. In addition, that what is necessary is just to form if needed, even if this solder bump is the case where a solder bump is not formed, she can mount these through the bump of the substrate for IC chip mounting, or various surface mount mold electronic parts who mounts.

Moreover, it is good also as PGA (Pin Grid Array) or BGA (Ball Grid Array) by not forming an external connection terminal, arranging a pin or forming a solder ball if needed, especially in the solder resist layer of the substrate for IC chip mounting, the field which counters, and the opposite side.

By passing through such a process, the multilayer printed wiring board which constitutes the device for optical communication of this invention can be manufactured.

[0207]

By the manufacture approach of the device for optical communication of this invention next, between the optical element of the substrate for IC chip mounting, and the optical waveguide of a multilayer printed wiring board, both are stationed in the location which can perform transmission of a lightwave signal through the resin packed bed for optical paths, and it fixes to it.

Here, both are fixed, while forming a solder connection by the solder bump of the above-mentioned substrate for IC chip mounting, and the solder bump of the above-mentioned multilayer printed wiring board and connecting both electrically, after carrying out opposite arrangement of the substrate for IC chip mounting, and the multilayer printed wiring board. That is, both are connected by carrying out opposite arrangement and carrying out a reflow of the substrate for IC chip mounting, and the multilayer printed wiring board to a position with the predetermined sense, respectively.

In addition, as mentioned above, the solder bump for fixing both substrate for IC chip mounting and multilayer printed wiring board may be formed only in one of both.

[0208]

Moreover, at this process, even if some location gap exists among both when opposite arrangement of both is carried out in order to connect the substrate for IC chip mounting, and a multilayer printed wiring board using both solder bump, both can be stationed to a position according to the self-alignment effectiveness which solder has at the time of a reflow.

[0209]

Next, the resin constituent for the closures is slushed between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, and a closure resin layer is formed in it by performing hardening processing after that.

Silicone resin mentioned above as the above-mentioned resin constituent for the closures, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA; that with which resinous principles, such as a polymer

manufactured from benz-cyclo-butene, and the particle contained if needed were resembled, in addition various additives, such as a curing agent, a defoaming agent, an acid anhydride, and a solvent, were blended suitably is mentioned.
Moreover, as for the above-mentioned resin constituent for the closures, it is desirable for the permeability of the communication link wavelength light after hardening to be 70% or more, and it is more desirable that it is 90% or more.
[0210]
What is necessary is here, just to choose suitably in consideration of the design of the presentation of the resin constituent for the closures, the substrate for IC chip mounting, and a multilayer printed wiring board etc. as the viscosity of the resin constituent for the closures slushed between the substrate for IC chip mounting, and a multilayer printed wiring board, and conditions for the hardening processing after slushing this resin constituent for the closures.
[0211]
Next, IC chip is mounted in the substrate for IC chip mounting, and it considers as the device for optical communication by performing the resin seal of IC chip after that if needed.
Mounting of the above-mentioned IC chip can be conventionally performed by the well-known approach.
Moreover, it is good also as a device for optical communication by connecting the substrate for IC chip mounting and multilayer printed wiring board which performed mounting of IC chip before connecting the substrate for IC chip mounting, and a multilayer printed wiring board, and mounted IC chip.
[0212]
[Example]
Hereafter, this invention is further explained to a detail.
(Example 1)
A. Production of the substrate for IC chip mounting
A-1. Production of a package substrate
(a) Production of the resin film for the resin insulating layers between layers
The bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy company) 30 weight section, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N-673 by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin (phenol nature hydroxyl equivalent 120, FENO [by Dainippon Ink & Chemicals, Inc.] light KA- 7052) 30 weight section The ethyl diethylene glycol acetate 20 weight section, The heating dissolution is carried out stirring in the solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers formation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5-screw (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and the silicone system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was prepared.
After applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a PET film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for the resin insulating layers between layers was produced by making it dry for 10 minutes at 80-120 degrees C.
[0213]
(b) Adjustment of a resin filler (resin constituent)
The mean particle diameter by which coating of the silane coupling agent was carried out to the bisphenol female mold epoxy monomer (oil-ized shell company make, molecular weight : 310 YL983U) 100 weight section and a front face by 1.6 micrometers The diameter of grain of maximum size for a container the SiO2 spherical-particle (Adtec Corp. make, CRS 1101-CE) 170 weight section 15 micrometers or less and the leveling agent (Sannopuko PERENORU S4) 1.5 weight section by carrying out stirring mixing The viscosity prepared the resin filler of 45-49Pa and s at 23**1 degree C. In addition, the imidazole curing agent (Shikoku formation shrine make, 2E4 MZ-CN) 6.5 weight section was used as a curing agent.
[0214]

(c) Manufacture of a package substrate
(1) Double-sided copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of a glass epoxy resin with a thickness of 0.8mm or BT (bismaleimide triazine) resin was used as the start ingredient (refer to drawing 4 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern -- both sides of a substrate 21 -- a conductor -- the circuit 24 and the through hole 29 were formed (refer to drawing 4 (b)).
[0215]
(2) a lower layer -- a conductor -- washing in cold water the substrate 21 in which the circuit 24 was formed, and, after drying Melanism processing the water solution containing NaOH (10g/(l.)), NaClO2 (40 g/l), and Na3PO4 (6 g/l) -- melanism -- it considers as a bath (oxidation bath) -- and the lower layer which performs reduction processing which makes a reduction bath NaOH (10 g/l) and the water solution containing NaBH4 (6 g/l), and includes a through hole 29 -- a conductor -- the roughening side (not shown) was formed in the front face of a circuit 24.
[0216]
(3) next, the following approach after preparing the resin filler indicated above (b) -- after preparation -- less than 24 hours -- the conductor in a through hole 29 and on a substrate 21 -- the circuit agenesis section and a conductor -- the layer of resin filler 30' was formed in the rim section of a circuit 24.
That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor -- the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee -- the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 4 (c)).
[0217]
(4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 -- a conductor -- it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate.
Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.
[0218]
thus, a through hole 29 and a conductor -- the surface section of the resin filler layer 30 formed in the circuit agenesis section, and a conductor -- the front face of a circuit 24 -- flattening -- carrying out -- the resin filler layer 30 and a conductor -- the insulating substrate which the side face of a circuit 24 stuck firmly through the roughening side, and the internal surface and the resin filler 30 of a through hole 29 stuck firmly through the roughening side was obtained (refer to drawing 4 (d)). this process -- the front face of the resin filler layer 30, and a conductor -- the front face of a circuit 24 turns into the same flat surface.
[0219]
(5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate -- carrying out -- subsequently -- an etching reagent -- both sides of a substrate -- a spray -- spraying -- a conductor -- etching the front face of a circuit 24, and the land front face of a through hole 29 -- a conductor -- the roughening side (not shown) was formed in all the front faces of a circuit 24. As an etching reagent, the etching reagent (the product made from MEKKU, MEKKU dirty bond) containing the imidazole copper (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0220]
(6) Next, by 0.5MPa, it laminated vaccum pressure arrival, the resin film for the resin insulating

layers between layers produced above (a) was stuck, carrying out a temperature up to the temperature of 50-150 degrees C, and resin film layer 22alpha was formed (refer to drawing 4 (e)).
[0221]
(7) Next, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in resin insulating-layer 22between layers alpha by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which the through tube with a thickness of 1.2mm was formed on resin insulating-layer 22between layers alpha on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the through tube of a mask, and the conditions of one shot (refer to drawing 5 (a)).
[0222]
(8) The roughening side (not shown) was formed in the front face of the resin insulating layer between layers containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution removal of the epoxy resin particle which exists in the front face of the resin insulating layer 22 between layers.
[0223]
(9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI).
Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the resin insulating layer 22 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride ($PdCl_2$) and a stannous chloride ($SnCl_2$), and the catalyst was given by depositing a palladium metal.
[0224]
(10) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the non-electrolytic copper plating film 32 with a thickness of 0.6-3.0 micrometers was formed on the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers (refer to drawing 5 (b)).
[0225]
[Nonelectrolytic plating liquid]
$NiSO_4$ 0.003 mol/l
Tartaric acid 0.200 mol/l
Copper sulfate 0.030 mol/l
HCHO 0.050 mol/l
NaOH 0.100 mol/l
alpha and alpha'-bipyridyl 100 mg/l
Polyethylene-glycol (PEG) 0.10 g/l
[Nonelectrolytic plating conditions]
It is 40 minutes by whenever [30-degree C solution temperature].
[0226]
(11) Next, plating resist 23 was formed by sticking a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 5 (c)).
[0227]
(12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 was formed in the plating-resist 23 agenesis section (refer to drawing 5 (d)).
[0228]

[Electrolysis plating liquid]
Sulfuric acid 2.24 mol/l
Copper sulfate 0.26 mol/l
Additive 19.5 ml/l
(Made in ATOTEKKU Japan, KAPARASHIDO GL)
[Electrolysis plating conditions]
Current density 1 A/dm2
Time amount 65 Part
Temperature 22**2 **
[0229]
(13) -- the conductor which carries out etching processing of the nonelectrolytic plating film under plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution removal and consists of non-electrolytic copper plating film 32 and electrolytic copper plating film 33 further after carrying out exfoliation removal of the plating resist 23 by KOH 5% -- the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 6 (a)).
[0230]
(14) -- further -- a conductor -- the substrate in which the circuit 25 grade was formed -- an etching reagent -- being immersed -- a conductor -- the roughening side (not shown) was formed in the front face of a circuit 25 (the Bahia hall 27 is included). In addition, as an etching reagent, the product made from MEKKU and MEKKU dirty bond were used.
[0231]
(15) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make --) dissolved in the methyl ethyl ketone trade name: -- the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku -- formation -- shrine make --) trade name: -- 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make --) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: -- the R604 4.5 weight section -- the same -- a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make --) trade name: -- the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make --) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent.
Moreover, in the case of 60min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold).
[0232]
(16) next, a conductor -- the above-mentioned solder resist constituent was applied, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of the substrate in which the circuit 25 grade was formed, the condition for 30 minutes at 70 degrees C, and layer 34alpha of a solder resist constituent was formed in them (refer to drawing 6 (b)). Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening was drawn is stuck to layer 34alpha of a solder resist constituent, and it exposes by the ultraviolet rays of 1000 mJ/cm2, and is DMTG.
The development was carried out with the solution and opening 31 was formed.
And further, it carried out at 120 degrees C for 1 hour for 1 hour, heat-treated [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, layer 34alpha of a solder resist constituent was stiffened, and the solder resist layer 34 which has opening 31 formed (refer to drawing 6 (c)).
[0233]

(17) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer was formed in a part of opening 31. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10-1 mol/l), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10 to 1 mol/l.) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the package substrate (refer to drawing 6 (d)). In addition, all over drawing, two-layer [of a nickel-plating layer and a gilding layer] is doubled, and it is indicated as the metal layer 36.
[0234]
A-2. Production of the substrate for optical element insertion
(1) Double-sided copper clad laminate which 18-micrometer copper foil 8 laminates to both sides of the insulating substrate 1 which consists of a glass epoxy group plate with a thickness of 0.8mm or BT (bismaleimide triazine) resin was used as the start ingredient (refer to drawing 7 (a)). First, the conductor layer 12 was formed in that front face (the wall surface of a through tube is included) by carrying out drill drilling of this copper clad laminate, and performing nonelectrolytic plating processing (refer to drawing 7 (b)).
[0235]
(2) Next, after washing in cold water the substrate 1 in which the conductor layer 12 was formed and drying, Melanism processing the water solution containing NaOH (10g/(l.)), NaClO2 (40 g/l), and Na3PO4 (6 g/l) -- melanism -- it considers as a bath (oxidation bath) -- And reduction processing which makes a reduction bath NaOH (10 g/l) and the water solution containing NaBH4 (6 g/l) was performed, and the roughening side (not shown) was formed in the front face of a conductor layer 12.
[0236]
(3) Next, after adjusting the resin filler indicated to (b) of the above A-1, the layer of resin filler 10' was formed in the through tube which formed the conductor layer 12 in the wall surface within 24 hours after adjustment by the following approach.
That is, after pushing in a resin filler in a through tube using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 7 (c)).
[0237]
(4) By belt sander polish using the belt abrasive paper (Sankyo Rikagaku make) of **600, one side of a substrate which finished processing of the above (3) was ground so that the exposure of the layer of resin filler 10' and the front face of a conductor layer 12 might become flat, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate.
Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 10 was formed (refer to drawing 7 (d)).
[0238]
(5) Next, the conductor layer 14 was formed by performing nonelectrolytic plating processing to one side of the substrate in which the conductor layer 12 was formed (refer to drawing 7 (e)).
In addition, the conductor layer 14 was beforehand formed in the field of the side which gives the palladium catalyst and does not form a conductor layer 14 by forming plating resist in the field which forms a conductor layer 14 at one side of a substrate.
[0239]
(6) the conductor of the substrate in which the conductor layer 12 and the conductor layer 14 were formed -- by performing etching processing, after forming etching resist (not shown) in the part equivalent to the circuit (land part of through hole is included) formation section the through hole 6 where the resin filler layer 10 was formed in the interior, and the lid plating layer 16 was formed in the upper part, and a conductor -- the circuit (not shown) was formed (refer to drawing 7 (f)).

[0240]
In addition, formation of etching resist stuck the commercial photosensitive dry film, laid the mask, exposed it by 100 mJ/cm2, and was performed by carrying out a development in a sodium-carbonate water solution 0.8%.
Moreover, etching processing was performed using the mixed liquor of a sulfuric acid and hydrogen peroxide solution.
[0241]
(7) next, the conductor of one side of a substrate -- the adhesives layer (not shown) was formed by applying epoxy resin adhesive to the circuit agenesis section.
(8) Further, the through tube 9 was formed in the center section of a substrate by router processing, and it considered as the substrate for optical element insertion (refer to drawing 7 (g)).
[0242]
A-3. Production of the substrate for IC chip mounting
(1) The laminating press by the mass lamination method was performed, and the substrate which stuck the package substrate produced by the above A-1 and the substrate for optical element insertion produced by the above A-2 through the adhesives layer formed in the above-mentioned substrate for optical element insertion was obtained (refer to drawing 8 (a)). That is, after performing both alignment, a temperature up is carried out to 150 degrees C, and the package substrate and the substrate for optical element insertion were stuck by pressing in a pan by the pressure of 5MPa(s).
[0243]
(2) Next, the photo detector 38 and the light emitting device 39 were attached in the front face of the package substrate exposed from the through tube 9 formed in the substrate for optical element insertion using the silver paste so that light sensing portion 38a and light-emitting part 39a might be up exposed, respectively.
In addition, as a photo detector 38, what consists of InGaAsP was used as a light emitting device 39 using what consists of InGaAs.
[0244]
(3) Next, the metal layer 36 of the front face of the par cage substrate exposed from the pad for electrical connection and through tube 9 of a photo detector 38 and a light emitting device 39 was connected by wirebonding (refer to drawing 8 (b)). Here, the wire made from Au was used as a wire 40.
[0245]
(4) Next, it was filled up with the resin constituent containing an epoxy resin by printing in the through tube 9 formed in the substrate for optical element insertion, and this resin constituent was dried after that.
Furthermore, buffing and mirror polishing were given to the exposure of a resin constituent.
Then, it heat-treated and considered as the resin packed bed 41 for optical paths (refer to drawing 8 (c)).
In addition, the refractive index is 1.60 and the permeability of the resin filler layer 41 for optical paths is 85%.
[0246]
(5) Next, the solder resist constituent adjusted at the process of (15) of production of the above-mentioned package substrate and the same resin constituent were adjusted, this was applied to the substrate side for optical element insertion of a substrate, for 20 minutes was performed at 70 degrees C, desiccation processing was performed the condition for 30 minutes at 70 degrees C, and layer 54alpha of a solder resist constituent was formed (refer to drawing 9 (a)). In addition, a solder resist constituent was not applied to the front face of the resin packed bed 41 for optical paths here.
Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening was drawn was stuck to layer 54alpha of a solder resist constituent, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening 51 was formed.

And further, it carried out at 120 degrees C for 1 hour for 1 hour, heat-treated [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, layer 54alpha of a solder resist constituent was stiffened, and the solder resist layer 54 which has opening 51 was formed (refer to drawing 9 (b)). Therefore, when this process is finished, the solder resist layer 54 will be formed in the substrate side for optical element insertion, and the solder resist layer 34 will be formed in the package substrate side, respectively.
[0247]
(6) Next, the substrate in which the solder resist layer 54 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10 to 1 mol/l.) for 20 minutes, and the nickel-plating layer 55 with a thickness of 5 micrometers was formed in a part of opening 51. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10 to 1 mol/l.), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, and the gilding layer 56 with a thickness of 0.03 micrometers was formed on the nickel-plating layer 55.
[0248]
(7) Next, soldering paste (Sn/Ag=96.5/3.5) was printed to the opening 51 formed in the solder resist layer 54, and the opening 31 which the solder resist layer 34 has, by carrying out a reflow at 250 degrees C, the solder bump 57 for IC chip mounting and the solder bump 58 for multilayer printed wiring board connection were formed, and the substrate for IC chip mounting was obtained (refer to drawing 9 (c)).
[0249]
B. Production of a multilayer printed wiring board
(a) Production of the resin film for the resin insulating layers between layers
The resin film for the resin insulating layers between layers was produced using the approach used by (a) of A-1, and the same approach.
(b) Preparation of a resin filler (resin constituent)
The resin filler was prepared using the approach used by (b) of A-1, and the same approach.
[0250]
(c) Manufacture of . multilayer printed wiring board
(1) Copper clad laminate which 18-micrometer copper foil 8 laminates to both sides of the insulating substrate 101 which consists of a glass epoxy resin with a thickness of 0.6mm or BT resin was used as the start ingredient (refer to drawing 10 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern -- both sides of a substrate 101 -- a conductor -- the circuit 104 and the through hole 109 were formed (refer to drawing 10 (b)).
[0251]
(2) a through hole 109 and a conductor -- the conductor which washes in cold water the substrate in which the circuit 104 was formed, sprays an etching reagent (the product made from MEKKU, MEKKU dirty bond) by the spray, and includes a through hole 109 after drying -- the roughening side (not shown) was formed in the front face of a circuit 104.
[0252]
(3) the following approach after preparing the resin filler indicated above (b) -- after preparation -- less than 24 hours -- the conductor in a through hole 109 and on a substrate 101 -- the circuit agenesis section and a conductor -- the layer of resin filler 110' was formed in the rim section of a circuit 104.
That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor -- the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee -- the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 110' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 10 (c)).
[0253]

(4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 -- a conductor -- it ground so that resin filler 110' might remain neither in the front face of a circuit 4, nor the land front face of a through hole 109, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate.
Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 110 was formed.
[0254]
thus, a through hole 109 and a conductor -- the surface section of the resin filler 110 formed in the circuit agenesis section, and a conductor -- the front face of a circuit 104 -- flattening -- carrying out -- the resin filler 110 and a conductor -- the insulating substrate which the side face of a circuit 104 stuck firmly through the roughening side, and the internal surface and the resin filler 110 of a through hole 109 stuck firmly through the roughening side was obtained (refer to drawing 10 (d)). this process -- the front face of the resin filler layer 110, and a conductor -- the front face of a circuit 104 turns into the same flat surface.
[0255]
(5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate -- carrying out -- subsequently -- an etching reagent -- both sides of a substrate -- a spray -- spraying -- a conductor -- etching the front face of a circuit 104, and the land front face of a through hole 109 -- a conductor -- the roughening side (not shown) was formed in all the front faces of a circuit 104. In addition, as an etching reagent, the product made from MEKKU and MEKKU dirty bond were used.
[0256]
(6) Next, the somewhat larger resin film for the resin insulating layers between layers than the substrate produced above (a) was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 102 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 10 (e)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.
[0257]
(7) Next, the opening 106 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 102 between layers by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which the through tube with a thickness of 1.2mm was formed on the resin insulating layer 102 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the through tube of a mask, and the conditions of one shot (refer to drawing 11 (a)).
[0258]
(8) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 106 for the Bahia halls by immersing the substrate in which the opening 106 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution removal of the epoxy resin particle which exists in the front face of the resin insulating layer 102 between layers.
[0259]
(9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI).
Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out roughening side processing (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 106 for the Bahia halls to be included) of the resin insulating layer 102 between layers by giving a palladium catalyst (not shown). That is, the

above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.
[0260]
(10) Next, the substrate was immersed into the non-electrolytic copper plating water solution, and the non-electrolytic copper plating film 112 with a thickness of 0.6-3.0 micrometers was formed in the front face (the internal surface of the opening 106 for the Bahia halls is included) of the resin insulating layer 102 between layers (refer to drawing 11 (b)).
In addition, the used nonelectrolytic plating water solution and nonelectrolytic plating conditions are the same as the process of (10) of production of a package substrate.
[0261]
(11) The substrate in which the nonelectrolytic plating film 112 was formed was rinsed, electrolysis plating was performed after that, and the electrolytic copper plating film 113 was formed on [whole] the nonelectrolytic plating film 112 (refer to drawing 11 (c)).
In addition, the used electrolysis plating water solution and electrolysis plating conditions are the same as the process of (12) of production of a package substrate.
[0262]
(12) Next, etching resist 103 was formed by sticking a commercial photosensitive dry film on the substrate with which the electrolytic copper plating film 113 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 11 (d)).
[0263] the conductor which consists of non-electrolytic copper plating film 112 and electrolytic copper plating film 113 by carrying out etching processing of
 (13), next an etching-resist agenesis subordinate's electrolytic copper plating film and nonelectrolytic plating film with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carrying out dissolution removal and carrying out exfoliation removal of the etching resist with a NaOH solution 5% after that -- the circuit 105 (the Bahia hall 107 is included) was formed (refer to drawing 12 (a)).
furthermore, an etching reagent (MEKKU dirty bond) -- using -- a conductor -- the roughening side (not shown) was formed in circuit 105 (the Bahia hall 107 is included) front face.
[0264]
(14) Next, the optical waveguide 118 (118a, 118b) which uses the following approaches for the position of resin insulating-layer 102 between layers front face, and has the optical-path conversion mirror 119 (119a, 119b) was formed (refer to drawing 12 (b)).
That is, beforehand, the optical waveguide (25 micrometers in width of face of 25 micrometers, thickness) of the shape of a film which consists of PMMA by which the tip formed 45-degree optical-path conversion mirror 119 in the end using the diamond saw which is 90 degrees of V types was stuck so that the side face of the other end by the side of optical-path conversion mirror agenesis and the side face of the resin insulating layer between layers might gather.
In addition, attachment of optical waveguide applies to 10 micrometers in thickness the adhesives which become an adhesion side with the resin insulating layer between layers of this optical waveguide from thermosetting resin, and was performed after sticking by pressure by making it harden at 60 degrees C for 1 hour.
In addition, in this example, although hardened on the conditions of 60 degrees C / 1 hour, step hardening may be performed depending on the case. It is because it is hard to generate stress by optical waveguide at the time of attachment.
[0265]
(15) Next, the solder resist constituent was prepared like the process of (15) of production of a package substrate, further, the above-mentioned solder resist constituent was applied by the thickness of 35 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of a substrate the condition for 30 minutes at 70 degrees C, and layer 114' of a solder REJISU constituent was formed in them (refer to drawing 12 (c)).
[0266]
(16) Subsequently, opening was formed by making one side of a substrate stick the photo mask

with a thickness of 5mm with which the pattern of opening for solder bump formation (opening for connecting with a package substrate) and opening for optical paths was drawn to a solder resist layer, exposing on it by the ultraviolet rays of 1000 mJ/cm2, and performing a development to it with a DMTG solution.
And further, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, a solder resist layer is stiffened, it has opening for solder bump formation (not shown), and the opening 111 for optical paths, and the solder resist layer 114 the thickness of whose is 20 micrometers was formed.
[0267]
(17) Next, it was filled up with the resin constituent containing the epoxy resin filled up with the process of (4) of production of the substrate for IC chip mounting in the opening 111 for optical paths, and the same resin constituent, and the resin layer 108 for optical paths was formed in the opening 111 for optical paths by performing heat-treatment after that. In addition, the refractive index is 1.60 and the permeability of the resin layer 108 for optical paths is 85%.
Next, like the process of (6) of production of the substrate for IC chip mounting, the nickel-plating layer and the gilding layer were formed and it considered as the solder pad (not shown).
[0268]
(18) Next, soldering paste was printed to opening for solder bump formation formed in the solder resist layer 114, and by carrying out a reflow at 200 degrees C, the solder bump (not shown) was formed in opening for solder bump formation, and it considered as the multilayer printed wiring board (refer to drawing 12 (d)).
[0269]
C. Manufacture of the device for IC mounting optical communication
First, IC chip was mounted in the substrate for IC chip mounting manufactured through the process of Above A, the resin seal was performed after that, and IC chip mounting substrate was obtained.
Next, by making a position carry out opposite arrangement and carrying out a reflow of this IC chip mounting substrate and the multilayer printed wiring board manufactured through the process of Above B to it at 200 degrees C, the solder bumps of both substrates were connected and the solder connection was formed.
[0270]
Next, it was filled up with the resin constituent for the closures between the multilayer printed wiring boards and the substrates for IC chip mounting which were connected through the solder connection, and by performing hardening processing after that, the closure resin layer was formed and it considered as the device for optical communication (refer to drawing 1).
In addition, the resin constituent containing an epoxy resin was used as a resin constituent for the closures.
Moreover, permeability was 85% and the refractive index of the formed closure resin layer was 1.60.
[0271]
(Example 2)
The resin constituent which contains olefine resin in case a closure resin layer is formed is used. The resin constituent which contains olefine resin in case a refractive index forms the closure resin layer of 1.58 at 88% and the transmission forms the resin packed bed for optical paths of the substrate for IC chip mounting and the resin layer for optical paths of a multilayer printed wiring board is used. At 80%, the permeability manufactured the device for optical communication like the example 1, except that the refractive index formed the resin packed bed for optical paths of 1.58.
[0272]
(Example 3)
The resin constituent which contains acrylic resin in case a closure resin layer is formed is used. The resin constituent which contains an epoxy resin in case a refractive index forms the closure resin layer of 1.50 at 85% and the transmission forms the resin packed bed for optical paths of

the substrate for IC chip mounting and the resin layer for optical paths of a multilayer printed wiring board is used. At 85%, the permeability manufactured the device for optical communication like the example 1, except that the refractive index formed the resin packed bed for optical paths of 1.60.
[0273]
(Example 4)
The resin constituent which contains acrylic resin in case a closure resin layer is formed is used. The resin constituent which contains olefine resin in case a refractive index forms the closure resin layer of 1.50 at 85% and the transmission forms the resin packed bed for optical paths of the substrate for IC chip mounting and the resin layer for optical paths of a multilayer printed wiring board is used. At 80%, the permeability manufactured the device for optical communication like the example 1, except that the refractive index formed the resin packed bed for optical paths of 1.58.
[0274]
(Example 5)
After performing the process of (4) of production of the substrate for IC chip mounting of an example 1, the device for optical communication was manufactured like the example 1 except having used the following approach for the closure resin layer of the resin packed bed for optical paths, and the field of the side which counters, and having arranged the micro lens in them (refer to drawing 2).
That is, the resin constituent which uses a dispenser for the edge of the resin layer for optical paths, and contains an epoxy resin was dropped, and the micro lens was formed by performing hardening processing after that. In addition, the permeability is 92% and the refractive index of the micro lens formed here is 1.62.
[0275]
(Example 6)
In the example 2, after forming the resin packed bed for optical paths by performing the process of (4) of production of the substrate for IC chip mounting of an example 1, and the same process, the device for optical communication was manufactured like the example 2 except having used the following approach for the closure resin layer of this resin packed bed for optical paths, and the field of the side which counters, and having arranged the micro lens in them.
That is, the resin constituent which uses a dispenser for the edge of the resin layer for optical paths, and contains an epoxy resin was dropped, and the micro lens was formed by performing hardening processing after that. In addition, the permeability is 92% and the refractive index of the micro lens formed here is 1.62.
[0276]
(Example 7)
In the example 3, after forming the resin packed bed for optical paths by performing the process of (4) of production of the substrate for IC chip mounting of an example 1, and the same process, the device for optical communication was manufactured like the example 3 except having used the following approach for the closure resin layer of this resin packed bed for optical paths, and the field of the side which counters, and having arranged the micro lens in them.
That is, the resin constituent which uses a dispenser for the edge of the resin layer for optical paths, and contains an epoxy resin was dropped, and the micro lens was formed by performing hardening processing after that. In addition, the permeability is 85% and the refractive index of the micro lens formed here is 1.60.
[0277]
(Example 8)
In the example 4, after forming the resin packed bed for optical paths by performing the process of (4) of production of the substrate for IC chip mounting of an example 1, and the same process, the device for optical communication was manufactured like the example 4 except having used the following approach for the closure resin layer of this resin packed bed for optical paths, and the field of the side which counters, and having arranged the micro lens in them.
That is, the resin constituent which uses a dispenser for the edge of the resin layer for optical

paths, and contains an epoxy resin was dropped, and the micro lens was formed by performing hardening processing after that. In addition, the permeability is 92% and the refractive index of the micro lens formed here is 1.62.
[0278]
(Example 9)
A. Production of the substrate for IC chip mounting
A-1. Production of a package substrate
(a) Production of the resin film for the resin insulating layers between layers, and preparation of a resin filler (resin constituent)
It carried out like (a) of A-1 of an example 1, and (b).
[0279]
(b) Manufacture of a package substrate
(1) Double-sided copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of a glass epoxy resin with a thickness of 0.8mm or BT (bismaleimide triazine) resin was used as the start ingredient (refer to drawing 13 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern -- both sides of a substrate -- a lower layer -- a conductor -- the circuit 24 and the through hole 29 were formed (refer to drawing 13 (b)).
[0280]
(2) a lower layer -- a conductor -- washing in cold water the substrate 21 in which the circuit 24 was formed, and, after drying Melanism processing the water solution containing NaOH (10g/(l.)), NaClO2 (40 g/l), and Na3PO4 (6 g/l) -- melanism -- it considers as a bath (oxidation bath) -- and the reduction processing which makes a reduction bath NaOH (10 g/l) and the water solution containing NaBH4 (6 g/l) -- carrying out -- a lower layer -- a conductor -- the roughening side (not shown) was formed in the front face of a circuit 24.
[0281]
(3) next, the following approach after preparing the resin filler indicated above (a) -- after preparation -- less than 24 hours -- the conductor in a through hole 29 and on a substrate 21 -- the circuit agenesis section and a lower layer -- a conductor -- the layer of resin filler 30' was formed in the rim section of a circuit 24.
That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor -- the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee -- the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 13 (c)).
[0282]
(4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 -- a conductor -- it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of processings were similarly performed about the field of another side of a substrate.
Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.
[0283]
thus, a through hole 29 and a conductor -- the surface section of the resin filler layer 30 formed in the circuit agenesis section, and a conductor -- the front face of a circuit 24 -- flattening -- carrying out -- the resin filler layer 30 and a conductor -- the insulating substrate which the side face of a circuit 24 stuck firmly through the roughening side, and the internal surface and the resin filler layer 30 of a through hole 29 stuck firmly through the roughening side was obtained (refer to drawing 13 (d)). this process -- the front face of the resin filler layer 30, and a

conductor -- the front face of a circuit 24 turns into the same flat surface.
[0284]
(5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate -- carrying out -- subsequently -- an etching reagent -- both sides of a substrate -- a spray -- spraying -- a conductor -- etching the front face of a circuit 24, and the land front face of a through hole 29 -- a conductor -- the roughening side (not shown) was formed in all the front faces of a circuit 24. In addition, as an etching reagent, the product made from MEKKU and MEKKU dirty bond were used.
[0285]
(6) Next, by 0.5MPa, it laminated vaccum pressure arrival, the resin film for the resin insulating layers between layers produced above (a) was stuck, carrying out a temperature up to the temperature of 50-150 degrees C, and resin film layer 22alpha was formed (refer to drawing 13 (e)).
[0286]
(7) Next, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in resin film layer 22alpha by CO2 gas laser with a wavelength of 10.4 micrometers through the mask with which the through tube with a thickness of 1.2mm was formed on resin film layer 22alpha on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the through tube of a mask, and the conditions of one shot (refer to drawing 14 (a)).
[0287]
(8) The roughening side (not shown) was formed in the front face of the resin insulating layer 22 between layers containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing 60g [/l.] permanganic acid, and carrying out dissolution removal of the epoxy resin particle which exists in the front face of the resin insulating layer 22 between layers.
[0288]
(9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI). Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the resin insulating layer 22 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.
[0289]
(10) Next, a substrate is immersed into the nonelectrolytic plating liquid used at the process of (10) of production of the package substrate of an example 1, and the non-electrolytic copper plating liquid of the same presentation. The non-electrolytic copper plating film (thin film conductor layer) 32 with a thickness of 0.6-3.0 micrometers was formed in the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers by processing on the same conditions (refer to drawing 14 (b)).
[0290]
(11) Next, plating resist 23 was formed by sticking a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 14 (c)).
[0291]
50-degree C water washes a substrate and it degreases. With 25-degree C water (12) Subsequently, after rinsing, By immersing a substrate into the electrolysis plating liquid used at the process of (12) of production of the package substrate of an example 1, and the electrolytic copper plating liquid of the same presentation, and processing on the same conditions, after a

sulfuric acid furthermore washes The electrolytic copper plating film 33 was formed in the plating-resist 23 agenesis section (refer to drawing 14 (d)).
[0292]
(13) -- the nonelectrolytic plating film under the plating resist 23 after carrying out exfoliation removal of the plating resist 23 by KOH 5% further -- the mixed liquor of a sulfuric acid and a hydrogen peroxide -- etching processing -- carrying out -- dissolution removal -- carrying out -- a conductor -- it considered as the circuit 25 (the Bahia hall 27 is included) (refer to drawing 15 (a)).
[0293]
(14) next, a conductor -- the substrate in which the circuit 25 grade was formed -- an etching reagent -- being immersed -- a conductor -- the roughening side (not shown) was formed in the front face of a circuit 25 (the Bahia hall 27 is included). In addition, as an etching reagent, the product made from MEKKU and MEKKU dirty bond were used.
[0294]
(15) Next, the solder resist constituent was prepared like the process of (15) of production of the package substrate of an example 1.
(16) next, a conductor -- the above-mentioned solder resist constituent was applied, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of the substrate in which the circuit 25 grade was formed, the condition for 30 minutes at 70 degrees C, and layer 34alpha of a solder REJISU constituent was formed in them (refer to drawing 15 (b)). Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening was drawn was stuck to layer 34alpha of a solder resist constituent, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening 31 was formed.
And further, it carried out at 120 degrees C for 1 hour for 1 hour, heat-treated [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, layer 34alpha of a solder resist constituent was stiffened, and the solder resist layer 34 which has opening 31 was formed (refer to drawing 15 (c)).
[0295]
(17) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer was formed in a part of opening 31. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10-1 mol/l), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer was formed on the nickel-plating layer, and it considered as the package substrate (refer to drawing 15 (d)). In addition, all over drawing, two-layer [of a nickel-plating layer and a gilding layer] is doubled, and it is indicated as the metal layer 36.
[0296]
B. Production of the substrate for optical element insertion
(1) One side copper clad laminate which 18-micrometer copper foil 8 laminates on one side of the insulating substrate 1 which consists of a glass epoxy resin with a thickness of 0.8mm or BT (bismaleimide triazine) resin was used as the start ingredient (refer to drawing 16 (a)). first, the thing for which the copper foil 8 of this one side copper clad laminate is etched in the shape of a pattern -- one side of a substrate -- a conductor -- the circuit 4 was formed (refer to drawing 16 (b)).
[0297]
(2) next, the conductor of a substrate -- the side in which the circuit 4 was formed -- a conductor -- the adhesives layer (not shown) was formed by applying epoxy resin adhesive to the circuit agenesis section.
(3) Further, the through tube 9 was formed in the center section of a substrate by router processing, and it considered as the substrate for optical element insertion (refer to drawing 16 (c)).

[0298]
C. Production of the substrate for IC chip mounting
(1) The laminating press by the mass lamination method was performed, and the substrate which stuck the package substrate produced by Above A and the substrate for optical element insertion produced by Above B through the adhesives layer formed in the above-mentioned substrate for optical element insertion was obtained (refer to drawing 17 (a)). That is, after performing both alignment, a temperature up is carried out to 150 degrees C, and the substrate for optical element insertion and the package substrate were stuck by pressing in a pan by the pressure of 5MPa(s).
[0299]
(2) Next, the photo detector 38 and the light emitting device 39 were attached in the front face of the package substrate exposed from the through tube 9 formed in the substrate for optical element insertion using the silver paste so that light sensing portion 38a and light-emitting part 39a might be up exposed, respectively.
In addition, as a photo detector 38, what consists of InGaAsP was used as a light emitting device 39 using what consists of InGaAs. Moreover, as a photo detector 38 and a light emitting device 39, the pad for electrical connection used what is prepared in the package substrate side from light sensing portion 38a and light-emitting part 39a.
[0300]
(3) Next, the metal layer 36 of the front face of the package substrate exposed from the pad for electrical connection and through tube 9 of a photo detector 38 and a light emitting device 39 was connected by wirebonding (refer to drawing 17 (b)). Here, the wire made from Au was used as a wire 40.
[0301]
(4) Next, it was filled up with the resin constituent containing an epoxy resin by printing in the through tube 9 formed in the substrate for optical element insertion, and this resin constituent was dried after that.
Furthermore, buffing and mirror polishing were given to the exposure of a resin constituent. Then, it heat-treated and considered as the resin packed bed 41 for optical paths (refer to drawing 17 (c)).
In addition, the refractive index is 1.60 and the permeability of the resin packed bed 41 for optical paths is 85%.
[0302]
(5) Next, the through tube 46 with a diameter of 400 micrometers which penetrates the substrate for optical element insertion and a package substrate was formed by drilling (refer to drawing 18 (a)). Furthermore, DESUMIA processing was performed to the wall surface of a through tube 46 by being immersed in the 80-degree C solution containing the permanganic acid of 60 g/l for 10 minutes.
[0303]
(6) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI).
Furthermore, the catalyst nucleus was made to adhere to the wall surface of a through tube 46 etc. by giving a palladium catalyst to the exposure of the substrate for optical element insertion containing the wall surface of a through tube 46, and a package substrate (not shown).
[0304]
(7) Next, the substrate was immersed into the non-electrolytic copper plating water solution, and the non-electrolytic copper plating film (thin film conductor layer) 52 with a thickness of 0.6-3.0 micrometers was formed in the exposure of the substrate for optical element insertion containing the wall surface of a through tube 46, and a package substrate (refer to drawing 18 (b)).
In addition, it processed on the same conditions using the same thing as the nonelectrolytic plating liquid used at the process of (10) at the time of producing a package substrate as nonelectrolytic plating liquid.
[0305]

(8) Next, plating resist 43 was formed by sticking a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 52 was formed, laying a mask, exposing by 100 mJ/cm2, and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 18 (c)).
[0306]
(9) Subsequently, 50-degree C water washed the substrate and it degreased, and with 25-degree C water, after rinsing, after the sulfuric acid washed further, electrolysis plating was performed, and the electrolytic copper plating film 53 was formed in the plating-resist 43 agenesis section (refer to drawing 19 (a)).
In addition, it processed on the same conditions using the same thing as the electrolysis plating liquid used at the process of (12) at the time of producing a package substrate as electrolysis plating liquid.
[0307]
(10) Further, after carrying out exfoliation removal of the plating resist 43 by KOH 5%, etching processing of the nonelectrolytic plating film under the plating resist 43 was carried out with the mixed liquor of a sulfuric acid and a hydrogen peroxide, and dissolution removal was carried out and it considered as the through hole 49 which penetrates the substrate for optical element insertion, and a package substrate (refer to drawing 19 (b)).
[0308]
(11) Next, the substrate in which the through hole 49 was formed was immersed in the etching reagent (the product made from MEKKU, MEKKU dirty bond), and the roughening side (not shown) was formed in through hole 49 wall surface (the front face of a land part is included). Next, after preparing the same resin constituent as the resin filler indicated to (a) of production of the above-mentioned package substrate, the layer of a resin filler was formed in the through hole 49 within 24 hours after preparation by the following approach.
That is, after pushing in a resin filler in a through hole 49 using a squeegee, the layer of a resin filler was formed by making it dry on 100 degrees C and the conditions for 20 minutes.
[0309]
Furthermore, by belt sander polish using the belt abrasive paper (Sankyo Rikagaku make) of **600, it ground so that a resin filler might not remain in the land front face of a through hole 49, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Furthermore, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the exposure from the through hole formed the flat resin filler layer 50 (refer to drawing 19 (c)).
[0310]
(12) Next, the solder resist constituent prepared at the process of (15) of production of the above-mentioned package substrate and the same resin constituent were prepared, this was applied to both sides of a substrate, for 20 minutes was performed at 70 degrees C, desiccation processing was performed the condition for 30 minutes at 70 degrees C, and layer 54alpha of a solder REJISU constituent was formed (refer to drawing 20 (a)). In addition, a solder resist constituent was not applied to the front face of the resin packed bed 41 here.
Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening was drawn was stuck to layer 54alpha of a solder resist constituent, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening 51 was formed.
And further, it carried out at 120 degrees C for 1 hour for 1 hour, heat-treated [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, layer 54alpha of a solder resist constituent was stiffened, and the solder resist layer 54 which has opening 51 was formed (refer to drawing 20 (b)).
[0311]
(13) Next, the substrate in which the solder resist layer 54 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10 to 1 mol/l.) for 20 minutes, and the nickel-plating layer 55 with a thickness of 5 micrometers was formed in a part of

opening 51. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10 to 1 mol/l.), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, and the gilding layer 56 with a thickness of 0.03 micrometers was formed on the nickel-plating layer.

[0312]

(14) Next, soldering paste (Sn/Ag=96.5/3.5) was printed to the opening 51 formed in the solder resist layer 54, by carrying out a reflow at 250 degrees C, the solder bump 57 for IC chip mounting and the solder bump 58 for multilayer printed wiring board connection were formed, and the substrate for IC chip mounting was obtained (refer to drawing 20 (c)).

[0313]

B. Production of a multilayer printed wiring board

The multilayer printed wiring board was manufactured like B of an example 1.

[0314]

C. Manufacture of the device for IC chip mounting optical communication

First, IC chip was mounted in the substrate for IC chip mounting manufactured through the process of Above A, the resin seal was performed after that, and IC chip mounting substrate was obtained.

Next, by making a position carry out opposite arrangement and carrying out a reflow of this substrate for IC chip mounting, and the multilayer printed wiring board manufactured at the process of Above B to it at 200 degrees C, the solder bumps of both substrates were connected and the solder connection was formed.

[0315]

Next, it was filled up with the resin constituent for the closures between the multilayer printed wiring boards and the substrates for IC chip mounting which were connected through the solder connection, and by performing hardening processing after that, the closure resin layer was formed and it considered as the device for optical communication. In addition, the resin constituent containing an epoxy resin was used as a resin constituent for the closures. Moreover, permeability was 85% and the refractive index of the formed closure resin layer was 1.60.

[0316]

(Example 10)

The device for optical communication was manufactured like the example 9 except having made the resin packed bed for optical paths into the two-layer structure which consists of a resin packed bed for inner layer optical paths, and a resin packed bed for outer layer optical paths. Specifically in the process of (4) of production of the substrate for IC chip mounting, the device for optical communication was manufactured like the example 9 except having used the following approach (refer to drawing 3).

That is, in the through tube formed in the substrate for optical element insertion, it was filled up with the resin constituent containing an epoxy resin, a silica particle (mean particle diameter: 0.5 micrometers), and a curing agent by printing to the same height as an optical element (a photo detector and light emitting device), and the resin packed bed for inner layer optical paths was formed by carrying out heat hardening of this resin constituent after that.

Subsequently, after being filled up with the resin constituent containing an epoxy resin by printing on the resin packed bed for inner layer optical paths in a through tube, this resin constituent was dried and buffing and mirror polishing were further given to the exposure of a resin constituent. Then, hardening processing was performed and the resin packed bed for outer layer optical paths was formed.

In addition, the refractive index is 1.60 and the permeability of the resin packed bed for outer layer optical paths is 85%.

[0317]

thus, about the device for IC mounting optical communication of the acquired examples 1-10 An optical fiber is attached in an exposure from the side face of the multilayer printed wiring board of the optical waveguide which counters a photo detector. After attaching a detector in an

exposure from the side face of the multilayer printed wiring board of the optical waveguide which counters a light emitting device, The place which detected the lightwave signal with the detector after making a lightwave signal calculate with delivery and IC chip through an optical fiber, The desired lightwave signal could be detected and the device for IC mounting optical communication manufactured in the examples 1-10 became clear [having the engine performance which can be enough satisfied as a device for optical communication].

[0318]

Moreover, even if compared with the device for optical communication manufactured using the same approach as examples 1-10 except having not performed formation of formation of a closure resin layer, the resin packed bed for optical paths, and the resin layer for optical paths, most guided wave loss between the light emitting device mounted in the substrate for IC chip mounting, and this light emitting device and the optical waveguide formed in the multilayer printed wiring board which counters was not falling.

[0319]

Furthermore, in the device for optical communication obtained in the examples 1-10, most location gaps from the design of an optical element (a photo detector and light emitting device) and optical waveguide were not seen.

[0320]

[Effect of the Invention]

Since the device for optical communication of this invention consists of a substrate for IC chip mounting with which the photo detector and the light emitting device were mounted in the position, and a multilayer printed wiring board with which optical waveguide was formed in the position as described above, its connection loss between the mounted optics is low, and excellent in connection dependability as a device for optical communication.

[0321]

Moreover, in the device for optical communication of this invention, since dust, a foreign matter, etc. which are floating the inside of air do not enter between an optical element and optical waveguide and transmission of a lightwave signal is not checked with this dust, foreign matter, etc. when the closure resin layer is formed between the substrate for IC chip mounting, and the multilayer printed wiring board, it will excel with the dependability as a device for optical communication.

Furthermore, since the duty with which this closure resin layer eases the stress generated between the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board can be achieved and it is harder coming to generate location gap of an optical element and optical waveguide when the closure resin layer is formed, it will excel with the dependability as a device for optical communication.

[0322]

By the manufacture approach of the device for optical communication of this invention, since a closure resin layer be form among both after arrange and fix the substrate for IC chip mounting, and a multilayer printed wiring board to a position, the device for optical communication with which dust, a foreign matter, etc. which be float the inside of air do not enter between an optical element and optical waveguide, and transmission of a lightwave signal be check can be manufacture suitably.

[0323]

Moreover, it is harder it coming to generate location gap of an optical element and optical waveguide in the obtained device for optical communication by being able to achieve the duty with which this closure resin layer eases the stress which originates in the difference of a coefficient of thermal expansion, and is generated between the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, and forming a closure resin layer by forming a closure resin layer between the substrate for IC chip mounting, and a multilayer printed wiring board.

Therefore, by the manufacture approach of this invention, the device for optical communication which is excellent in dependability can be manufactured suitably.

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 3] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 4] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 5] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 6] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 7] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 8] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 9] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 10] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 11] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 12] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 13] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 14] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 15] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 16] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 17] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 18] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 19] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.

[Drawing 20] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.

[Description of Notations]

100,200,300 Multilayer printed wiring board
101, 201, and 301 Substrate
102, 202, and 302 Resin insulating layer between layers
104, 204, and 304 a conductor -- circuit
107, 207, and 307 Bahia hall
109, 209, and 309 Through hole
111, 211, and 311 Opening for optical paths
114, 214, and 314 Solder resist layer
118, 218, and 318 Optical waveguide
119, 219, and 319 Optical-path conversion mirror
120, 220, the substrate for 320 IC chip mounting
1120, 2120, and 3120 Package substrate
1100, 2100, and 3100 Substrate for optical element insertion
1121, 2121, and 3121 Substrate
1122, 2122, and 3122 Resin insulating layer between layers
1124, 2124, and 3124 a conductor -- circuit
1127, 2127, and 3127 Bahia hall
1129, 2129, and 3129 Through hole
1134, 2134, and 3134 Solder resist layer
1138, 2138, and 3138 Photo detector
1139, 2139, and 3139 Light emitting device
140, a 240 IC chip
1141 2141 Resin packed bed for optical paths
150, 250, and 350 Device for optical communication
160, 260, and 360 Closure resin layer

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 3] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of this invention.
[Drawing 4] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 5] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 6] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 7] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 8] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 9] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 10] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 11] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 12] It is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board which constitutes the device for optical communication of this invention.
[Drawing 13] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 14] It is the sectional view showing typically a part of process which manufactures the substrate for IC chip mounting which constitutes the device for optical communication of this invention.
[Drawing 15] It is the sectional view showing typically a part of process which manufactures the

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[Description of Notations]
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